Systems LAB & Technical Marketing

LED lighting:
ST products and solutions

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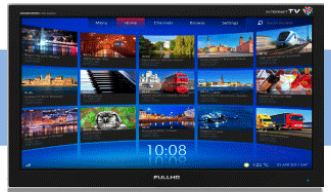
LED lighting by applications

General illumination

- Residential lighting
- Commercial lighting
- Architectural lighting
- Street lighting
- Large area illumination
- Emergency lighting

Consumer



- Notebooks, Netbooks
- Mid to large sized LCDs, LED TVs
- PDAs, MP3/PMP,
- Mobile, Smartphones
- Digital cameras
- Video game consoles
- General backlighting

Display and signage

- Stadium display
- Advertising display
- Video wall
- Traffic lights, road signs
- Transportation/ information display

Vehicle

- Interior lighting
- Exterior lighting
- Infotainment display backlighting

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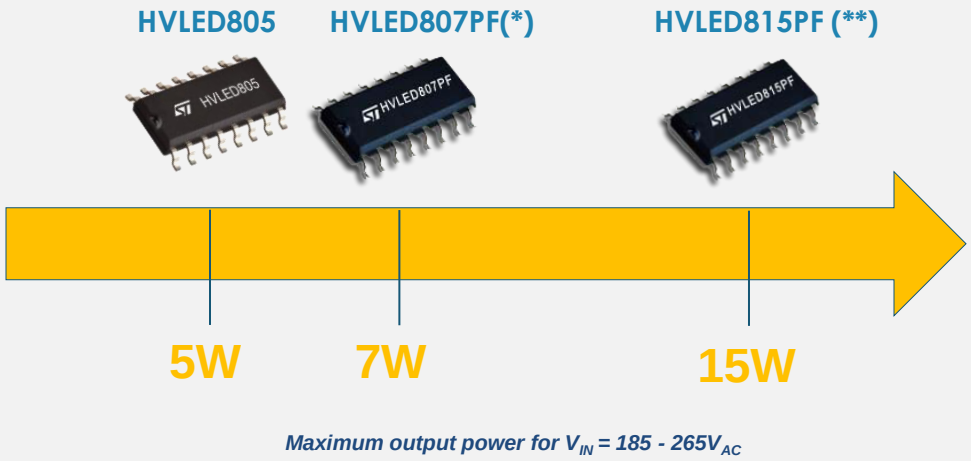
General illumination: AC-DC converters

HVLED family: off line LED drivers with primary sensing



Maximum output power for V_{IN} = 185 - 265V_{AC}

- Internal 800V avalanche rugged power MOSFET with Rdson =7Ω (HVLED815PF), 11 Ω (HVLED805/807PF)
- HV start up
- High power factor (HVLED807PF/815PF)
- LED output current regulation with Primary Sensing (*NO* secondary sensing and *NO* opto), 5% accuracy
- Quasi resonant operation mode
- Open & short LED string management
- Automatic self supply
- Input voltage feed forward for mains independent CC regulation

High PF > 5W
>0.7 residential
>0.9 commercial

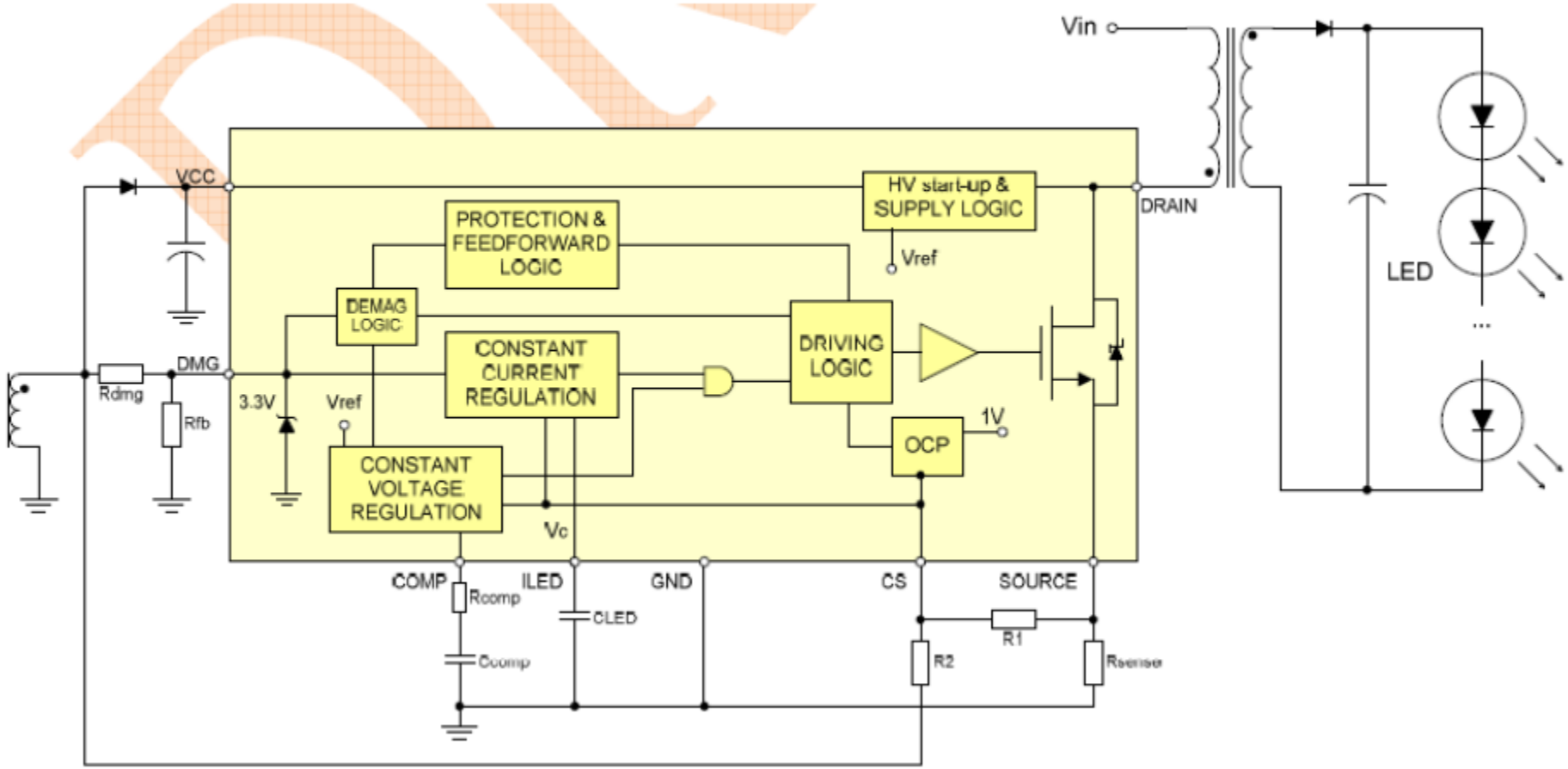
New HVLED807PF / 815PF

Off-line high power factor LED driver with all primary sensing

(**) Samples available in Q3 2012 (*) Samples available in Q4 2012

HVLED807PF and HVLED815PF

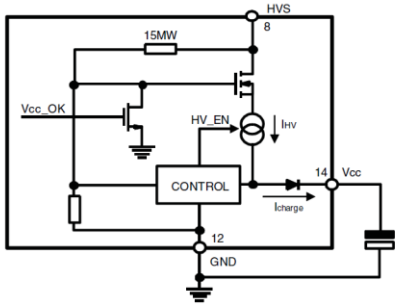
Low components count



General illumination: PFC controllers

L6564 series: transition mode PFC controllers

L6564H
Recommended for LED applications that must be compliant with energy saving regulations



High voltage start up generator: internal schematic

Main features

- ✓ Guaranteed extreme temperature range
- ✓ Fast bidirectional input voltage feedforward
- ✓ Accurate adjustable overvoltage protection
- ✓ Protection against feedback loop disconnection (latched shutdown)
- ✓ Inductor saturation protection
- ✓ AC brownout detection
- ✓ Low (≤100 µA) start up current
- ✓ 6 mA max operating bias current
- ✓ 1% (@ T_J= 25 °C) internal reference voltage
- ✓ 700V high voltage start up onboard

Suited for boost and high power factor flyback topologies

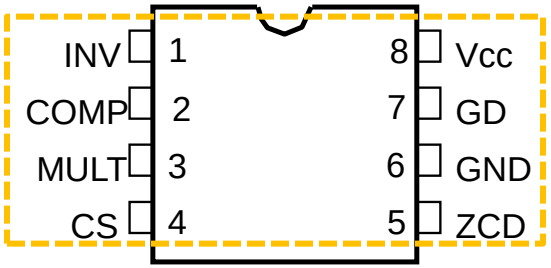
L6564
Recommended for LED tubes

L6564T
Recommended for LED outdoor applications

Electrical parameters guaranteed for Tj= -40 to 125°C

Product evolution for TM

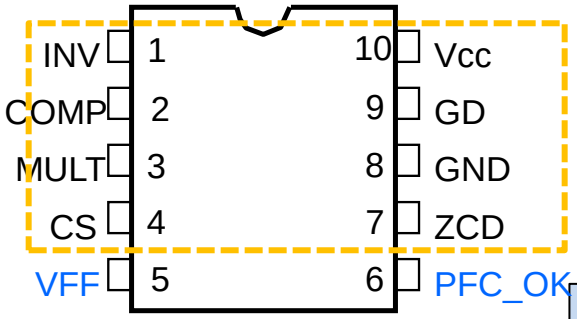
L6562A / AT



Low Cost

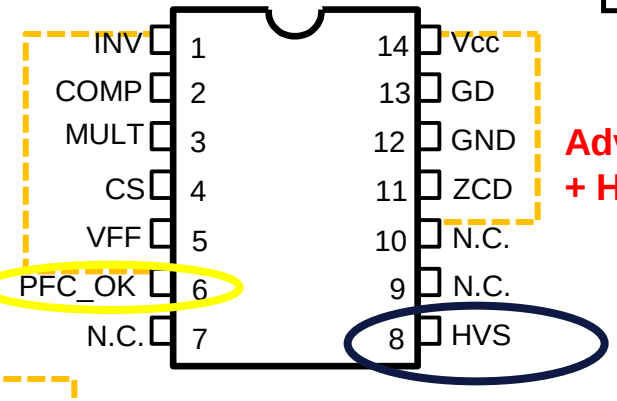
Adv. Features

L6564 / T



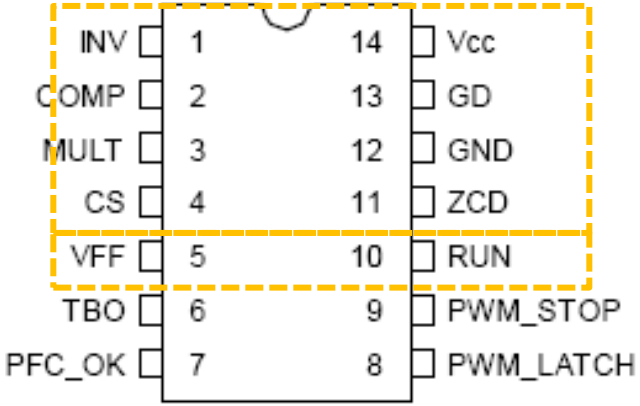
Advanced features
+ High Voltage Start up

L6564H



Interface to PWM ctrl

L6563S



Interface to PWM ctrl
+ High Voltage Start up

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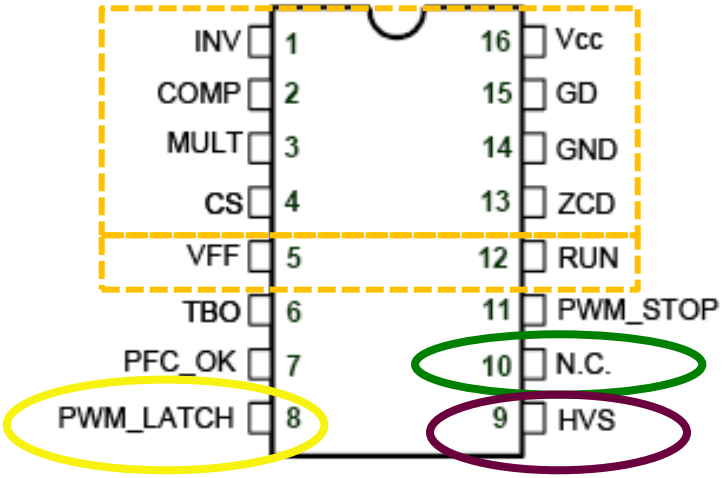
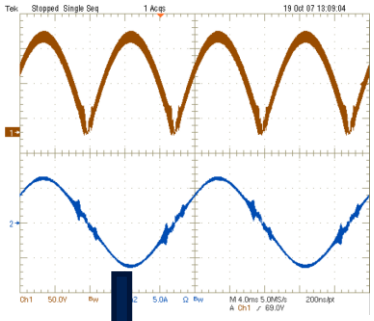
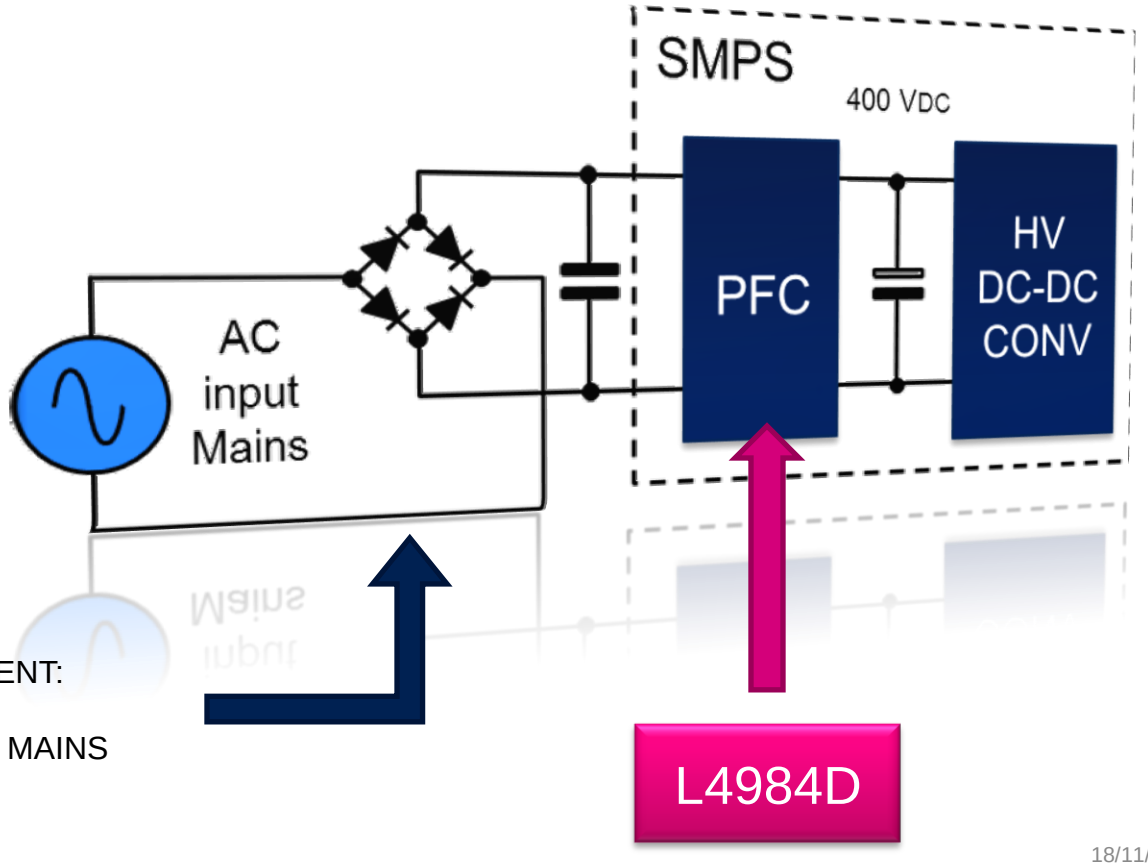


L4984D introduction

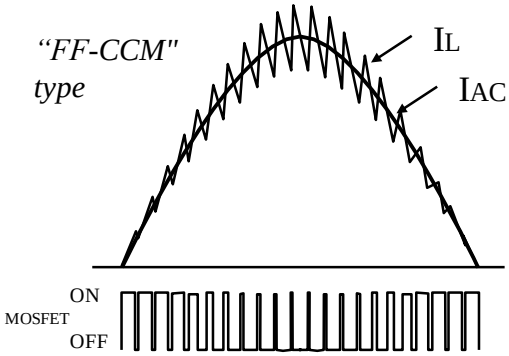
- L4984D, a Power Factor Controller:
  - for **Power Factor Control stages of SMPS** connected to AC input Mains
  - to make the application compliant to EN 61000-3-2 regulation by limiting the Total Harmonic Distortion (THD)



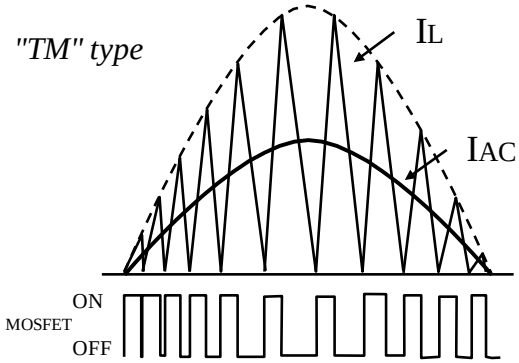


SMPS INPUT CURRENT:
- SINUSOIDAL
- IN PHASE WITH MAINS VOLTAGE

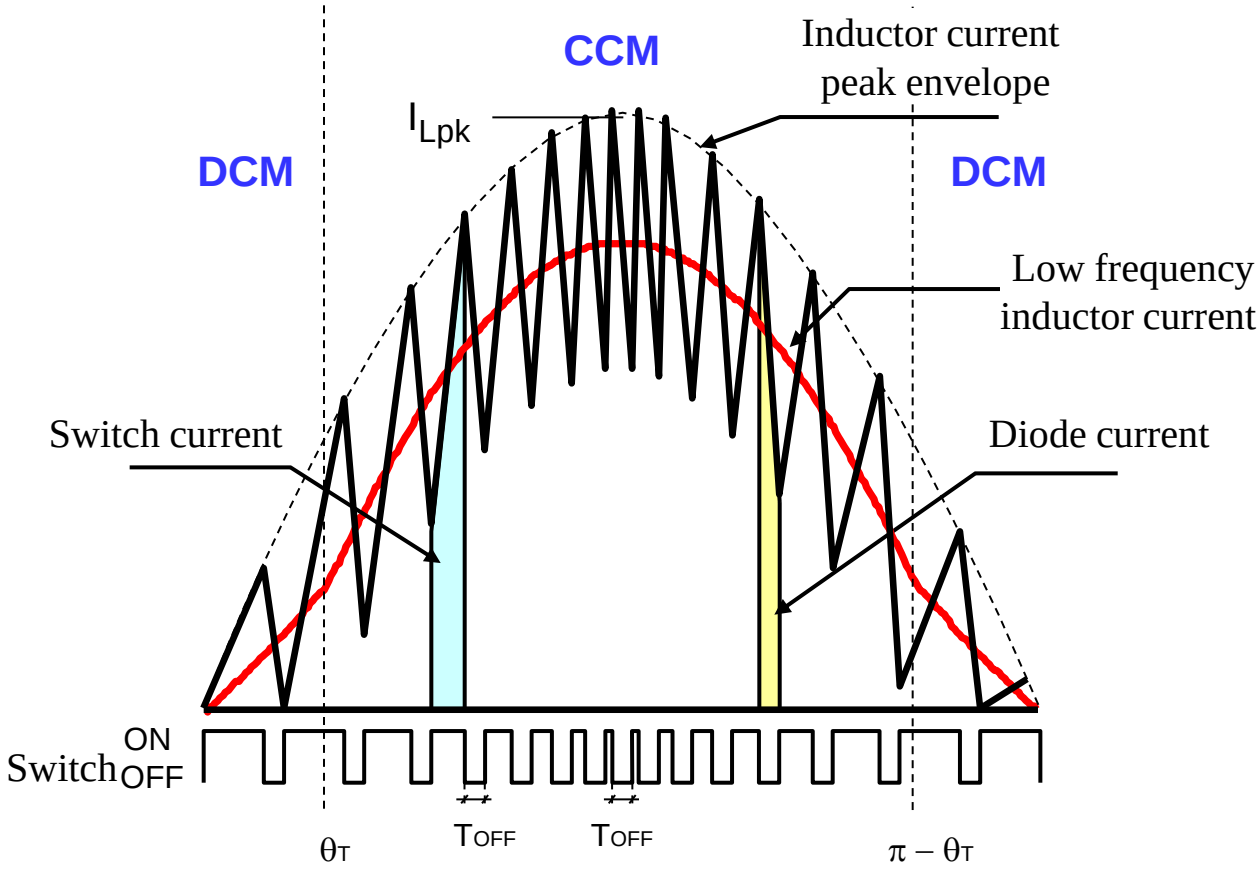
FOT-controlled PFC Pre-regulator



Continuous conduction



Transition mode

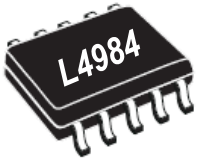


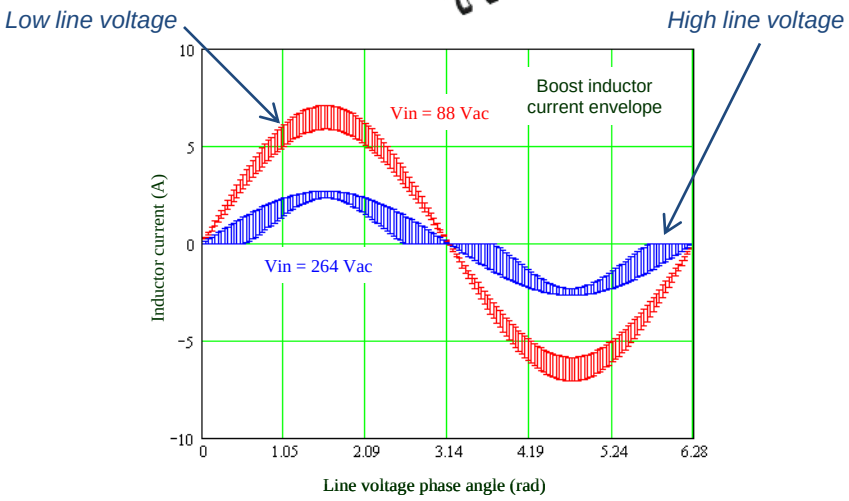
FOT = simplicity of TM control + benefit of CCM

Industrial: off-line SMPS ICs (10/16)

NEW

L4984: CCM PFC mode controller





Line modulated fixed off-time (LM-FOT) operated PFC

- ***Ton*** *fixed by peak inductor current programmed value*
- ***Toff*** *is voltage line modulated in such way the* ***Tsw*** *is costant as long as the boost converter operates in CCM*

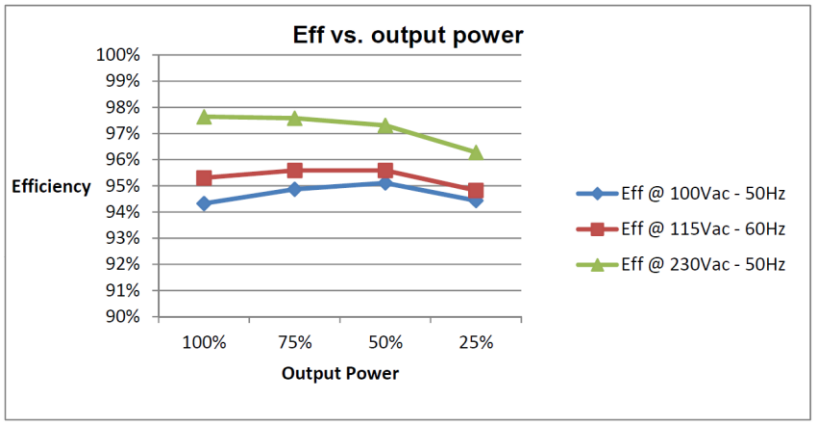
Main features

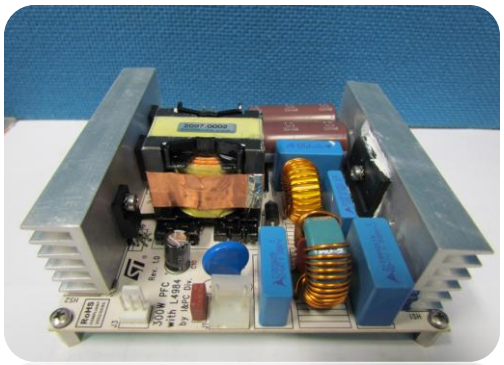
- Line-Modulated Fixed-Off-Time (LM-FOT) control of CCM-Operated PFC
- Proprietary LM-FOT modulator for nearly Fixed Frequency operation
- Fast Bidirectional Input Voltage Feedforward (1/V2)
- Precise Internal Reference (1% @25C)
- Accurate Adjustable OVP (No Latched)
- Protection against Feedback Loop Failure (Latched Shutdown)
- AC Brownout Detection
- DIGITAL Leading-edge blanking on Current Sense
- Low Start-up Current (<100µA)
- Remote ON/OFF control
- Inductor Saturation Protection (No Latched)
- Proprietary THD optimizer circuit
- -600 / +800mA totem pole gate driver with active pull-down and voltage clamp
- SSO10 (SO8 body size)

Low cost solution for CCM operated boost PFC pre-regulators for power higher than 250W

L4984D performances & tools

- **350W reference design (EVL4984-350W)**
  - Efficiency > 94% on 85VAC – 264VAC input range
  - THD<10% at full load on 85VAC – 264VAC input range

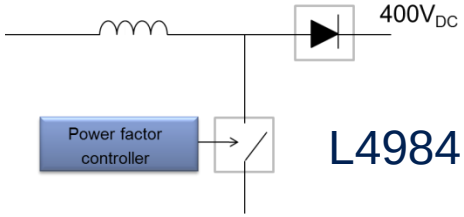




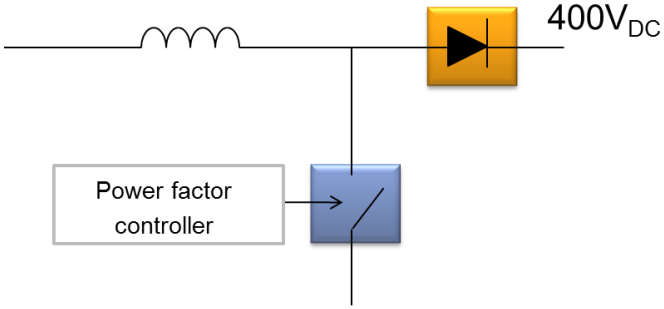
- **Design support**
  - **AN4149**: designing a CCM PFC pre-regulator with the L4984D
  - **AN4163**: 350W CCM PFC pre-regulator with the L4984D

  - Excel spreadsheet ***DESIGNING A FOT PFC USING THE L4984*** (AVAILABLE ON REQUEST)

L4984D companion MOSFET / rectifiers



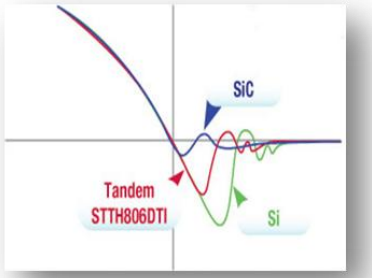
L4984 – 10 pin CCM power factor controller



RECTIFIER (600V reverse voltage)

- SiC (Silicon Carbide) → **STPSCxx06**
- Turbo 2 → **STTHxxR06**
- Tandem → **STTH806DTI**

The reverse recovery charge



SiC = $$, high efficiency
STD = $, lower efficiency

MOSFET (>500V breakdown)

- **High power** (>1kW) → **MDmesh V**
  e.g. STW69N65M5 for ~2KW
- **Medium power** (~200W to 1KW) → **MDmesh II Plus Low Qg**
  e.g. STP24N60M2 for ~400W

L4984D - summary

- L4984D is the right solution for middle-high power SMPS and is the **best trade-off** between full set features, performance and price.

- L4984D is able to address a wide range of applications:
  - SMPS for industrial, lighting & home appliances EMERGING
  - EV battery chargers EMERGING
  - Solar Inverters EMERGING
  - Servers SMPS for Data centers
  - high end game consoles, desktop, and workstation

  - *Suitable also for modified buck for LED applications from e.g 120VDC bus* EMERGING

General illumination: microcontrollers

NEW

STLUX385 (*): *8-bit low power microcontroller tailored for lighting applications*

Topologies supported

- Buck converter for LED driving
- Boost for PFC
- HB resonant converter for dimmable TL
- FB converter for HID

Special features

- 6 SMEDs (State Machine Event Driven) independent PWM programmable pulse signal generators
- Fast analog comparators (50ns max propagation delay)
- 96MHz PLL for high output signals resolution
- 10 bit, 8 multiplexed channels ADC with operation amplifier to extend resolution to 12 bit
- DALI hardware communication cell

Increased power processing with a wide range of features

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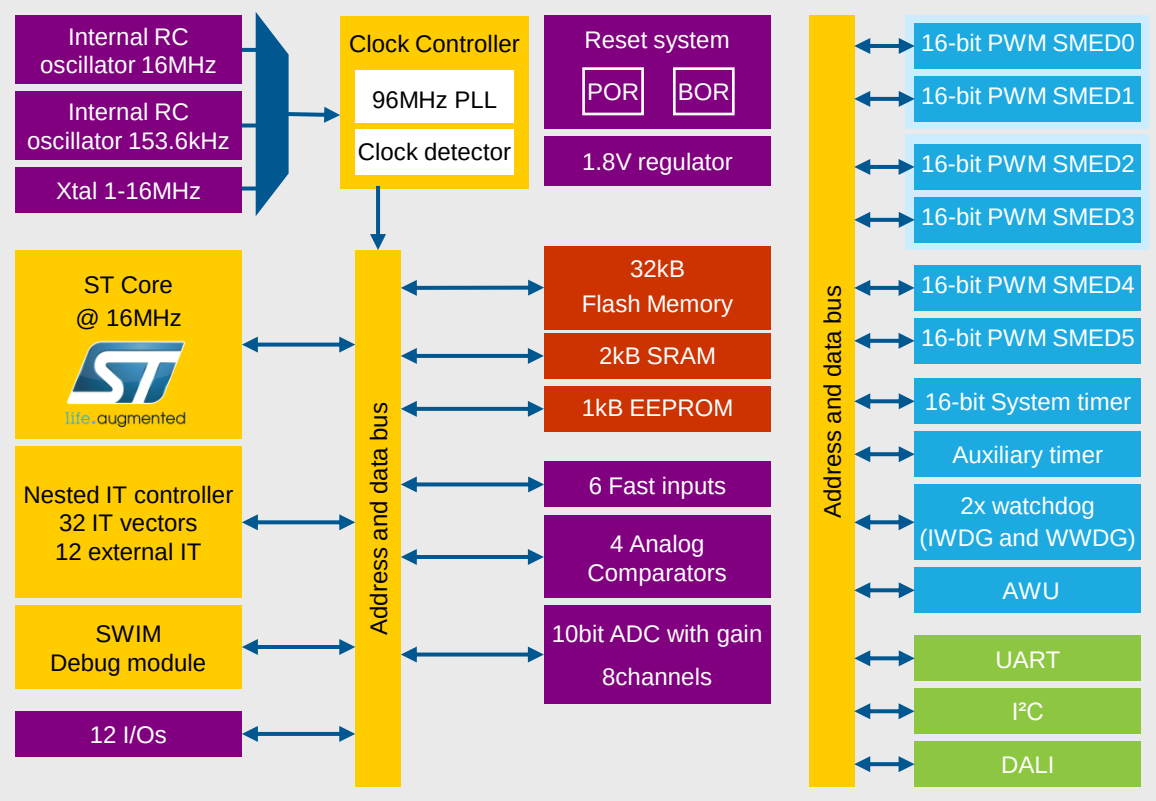
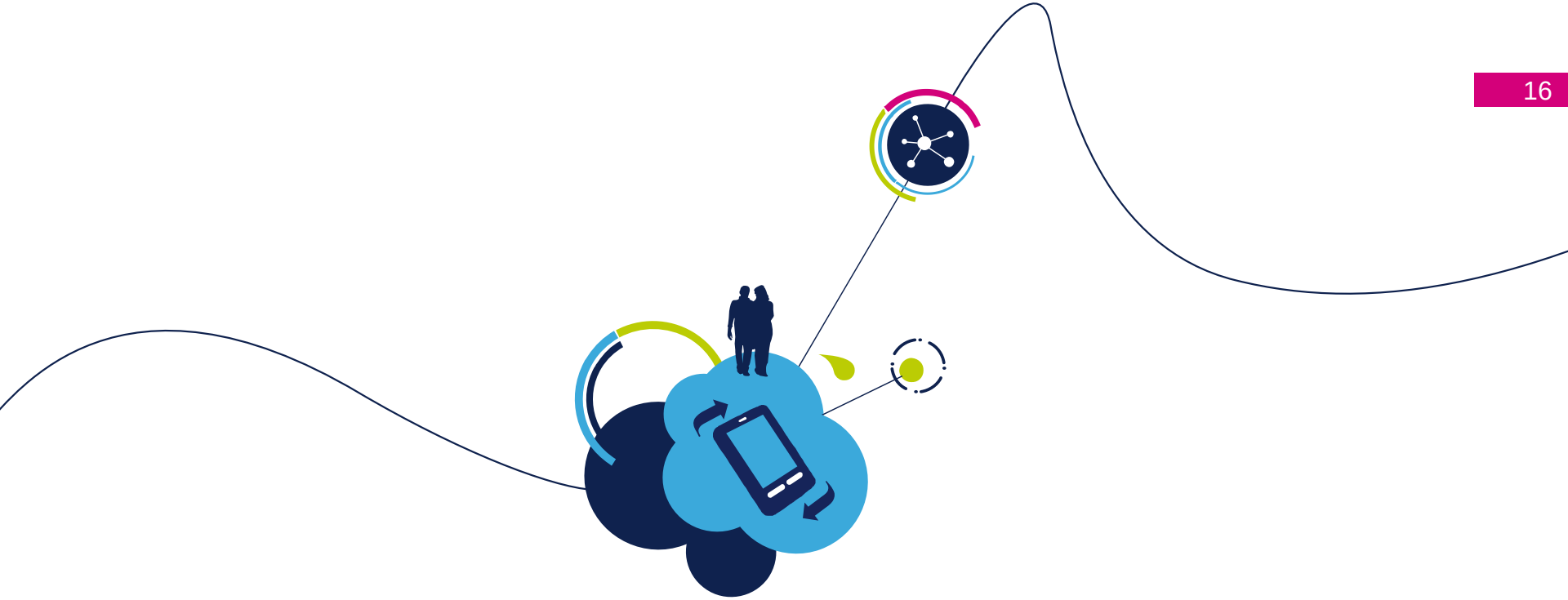
(*) Engineering samples available

STLUX385(A): block diagram

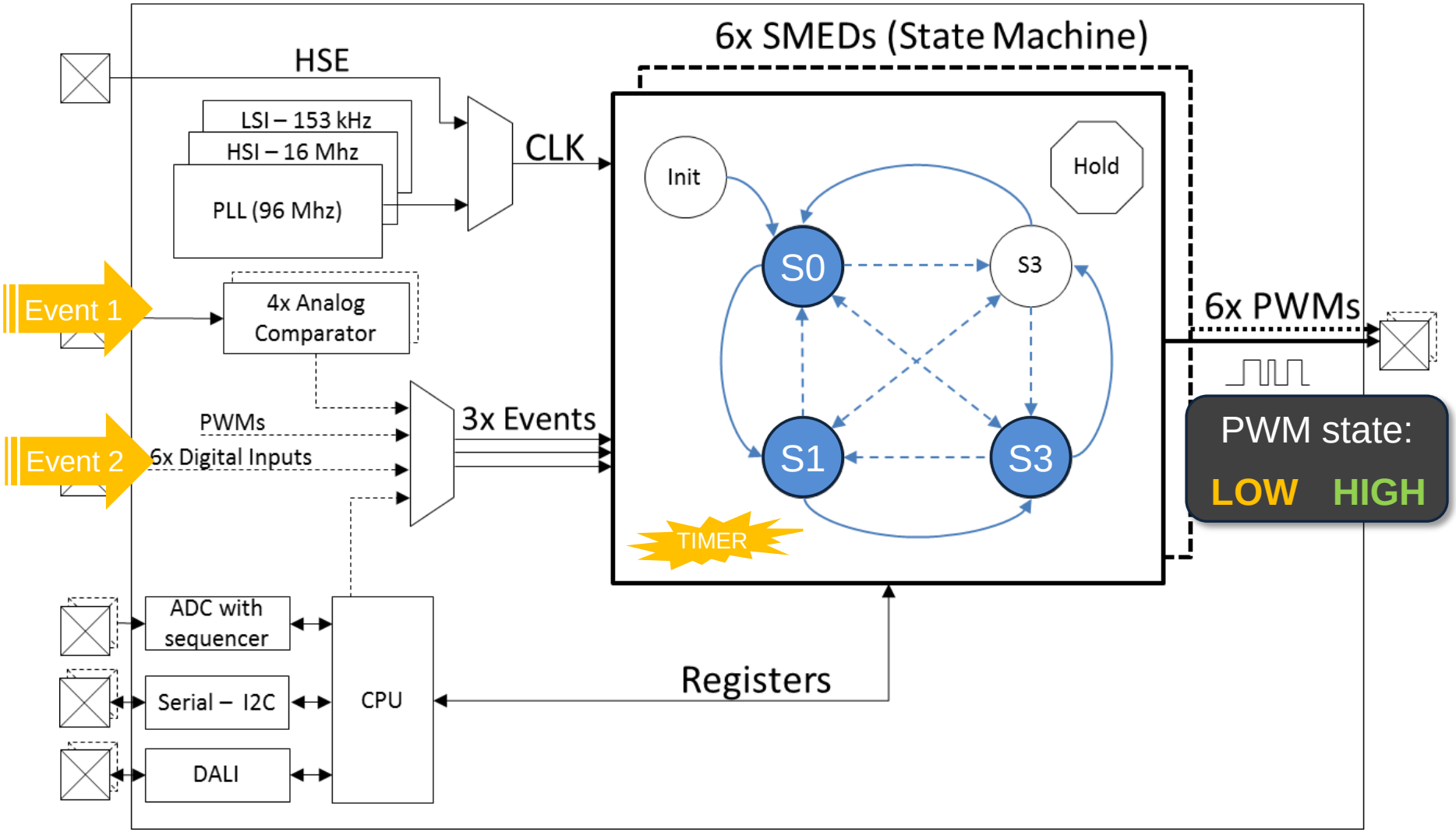


- **SIX** configurable PWM **S**tate **M**achine **E**vent **D**riven (SMED) up to 1.3ns average resolution
- 8 channels 10 bit ADC with programmable op amp GAIN (12 bit equivalent resolution), 2.4 µs conversion time,
- 4 Analog Comparators and 6 fast digital inputs synchronized with 96MHz clock
- ST proprietary core based (up to 20 MIPS)
  - 16-bit/8-bit and 16-bit/16-bit divisions
  - Faster 8-bit*8-bit multiplication, signed arithmetic operation
- 3V to 5.5V DC voltage supply (IC performances are optimized for 3.3V)
- -25 ºC (-40 ºC) to 105 ºC temperature range
- TSSOP38



STLUX CORE : SMED

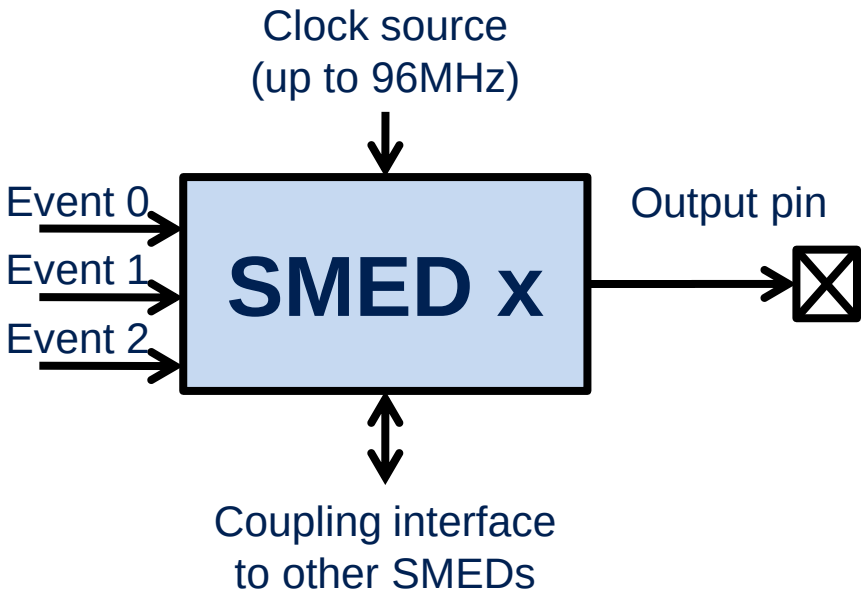
STLUX platform



SMED – Basic overview

State Machine – Event Driven

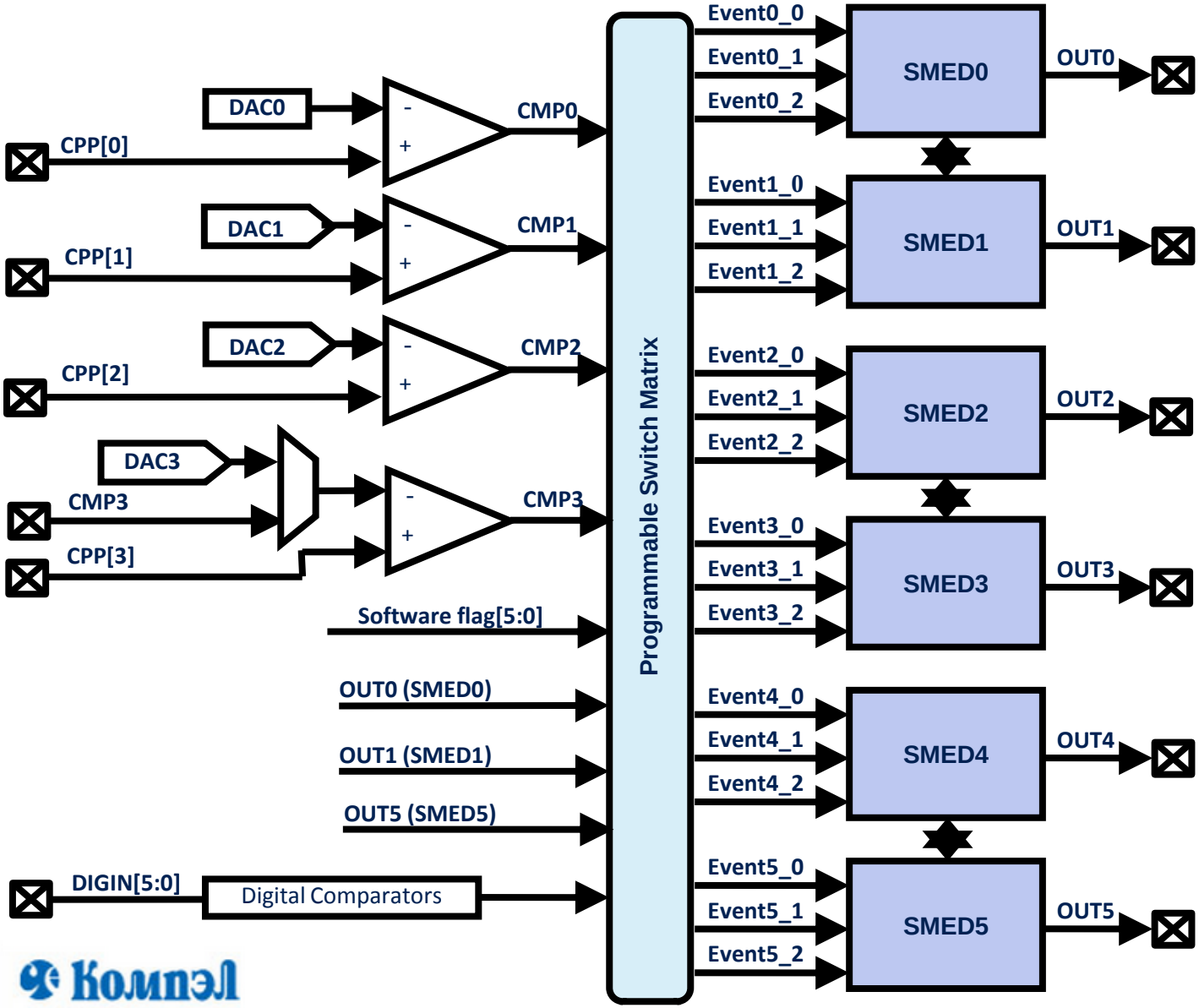
- **Signal generating machine**
- Software Configurable Peripheral
- Modular approach for maximum flexibility
- 6 independent SMED on STLUX385A



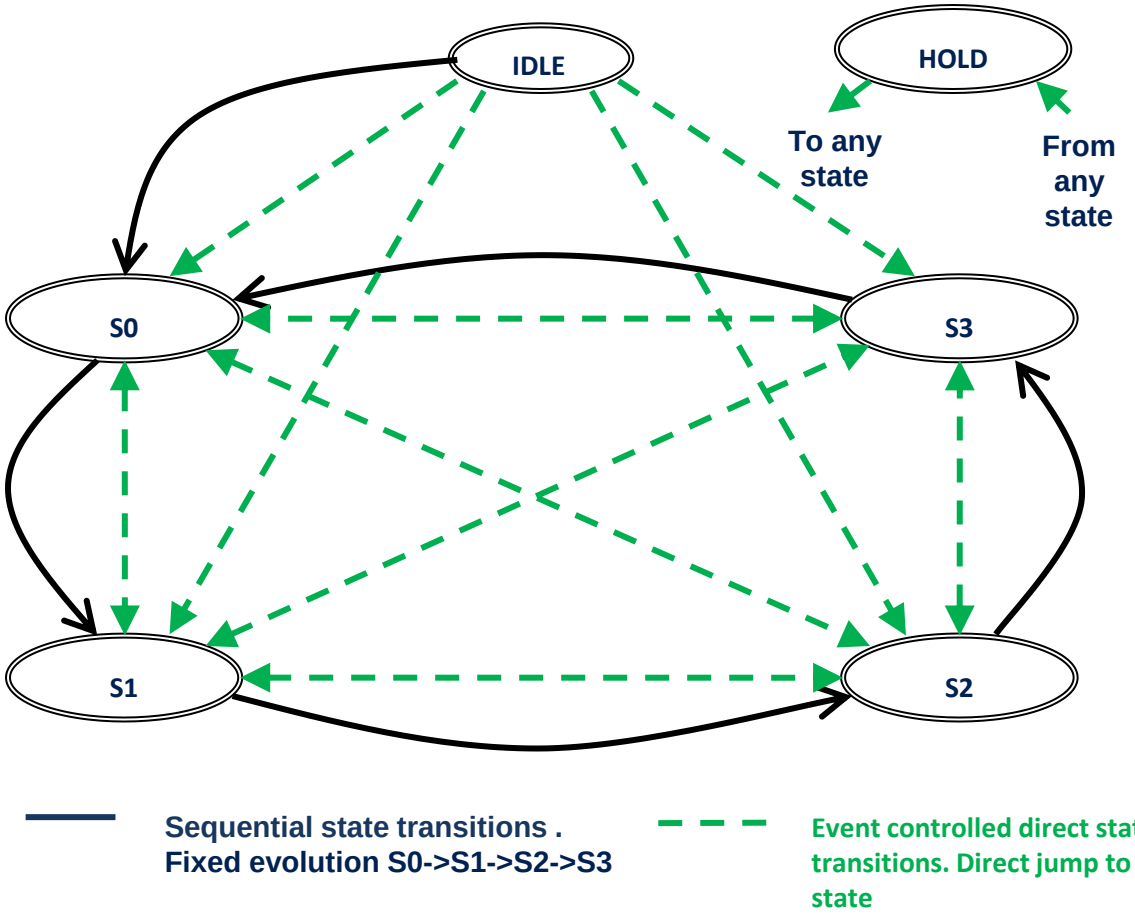
Each SMED integrates:

- One controlled output
- 3 programmable event inputs
- Edge/level event generation
- 16bits counter
- Clock frequency up to 96MHz
- Four 16bits time compare registers
- One 16bits dump register

Connection Switch Matrix – Input Events



State Machine - Complete



Each state has 3 configuration registers to program

- Conditions when the machine leaves the current state and what is the next state
- Actions to be done when leaving the state – (counter reset and/or output pin level)

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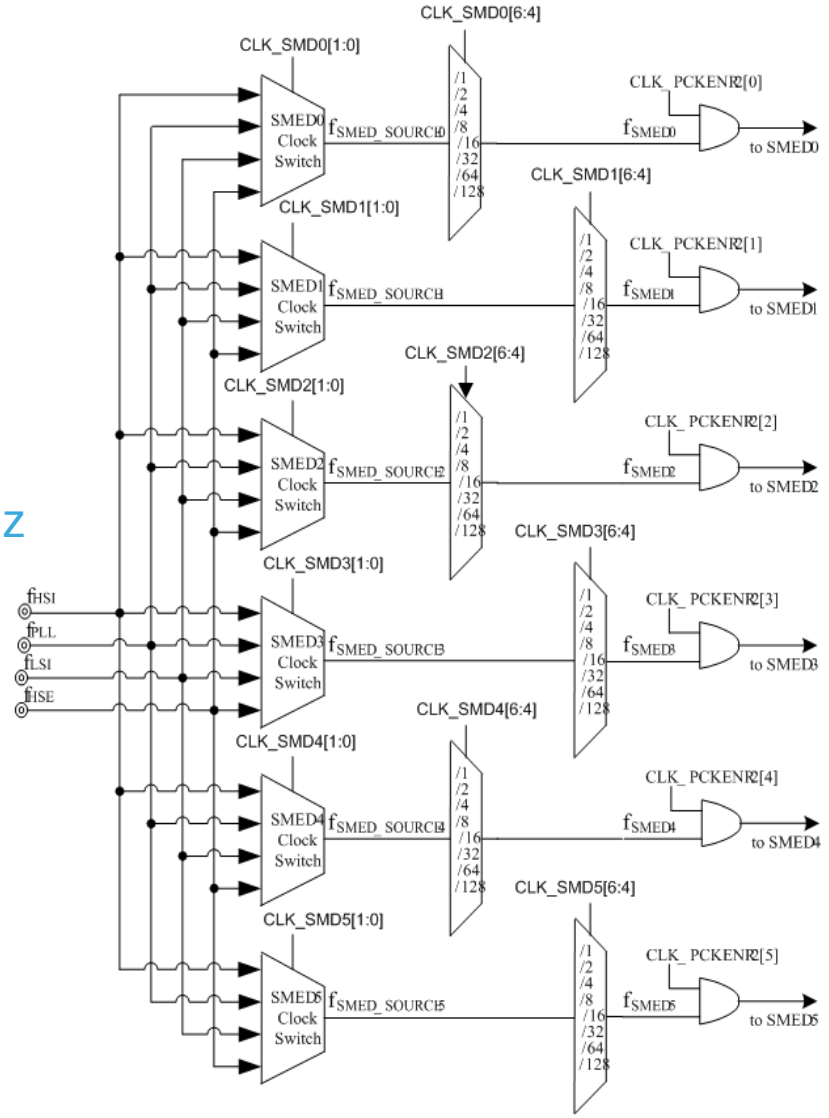
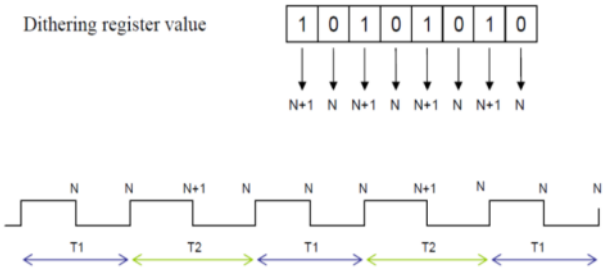
SMED Clock Sources

- Each SMED with independent clock

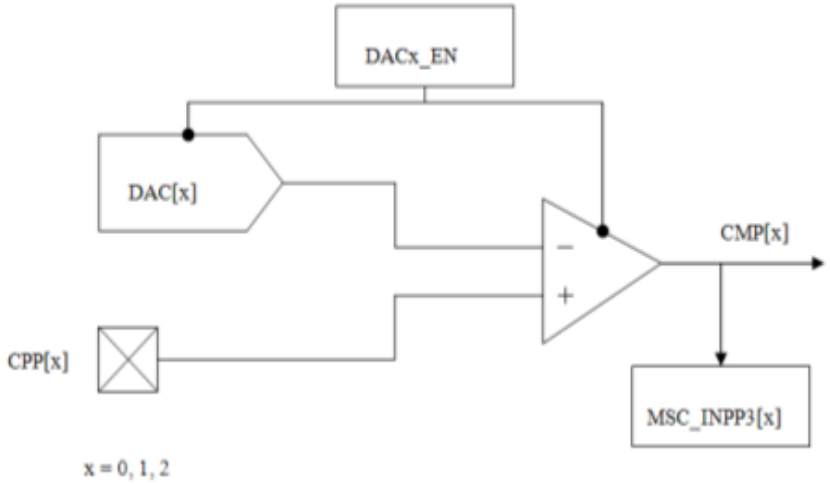
- 96MHz PLL+ programmable Dithering
  - 1.3ns average resolution
  - 13Hz average frequency step @ 100kHz
  - Higher resolutions even at low speed clocks

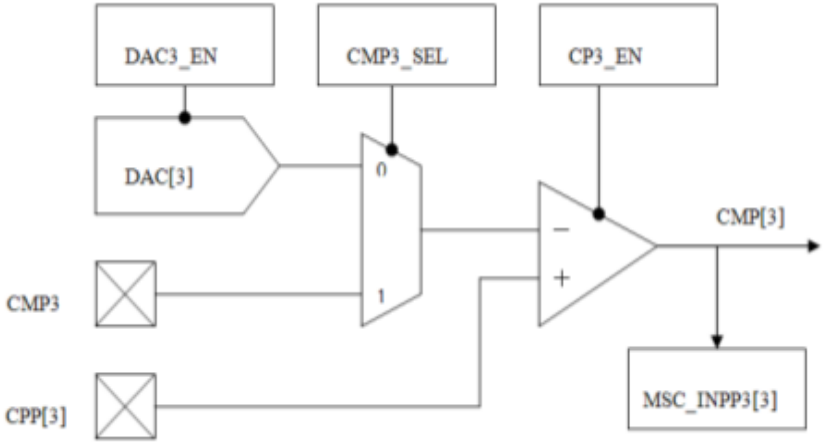




Analog Comparators

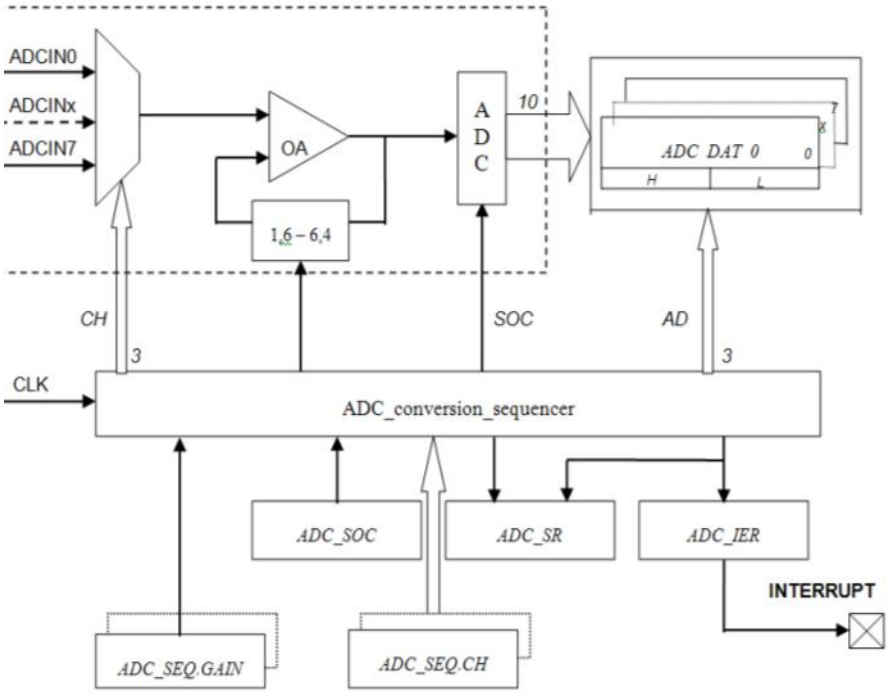
- Up to 4 independent comparators
- Very fast propagation delay (50 ns max)
- Internal 4 bit DAC reference: 16 values selectable from 0 to 1.23 V (bandgap reference)
- One comparator available with external reference





Analog to Digital Converter

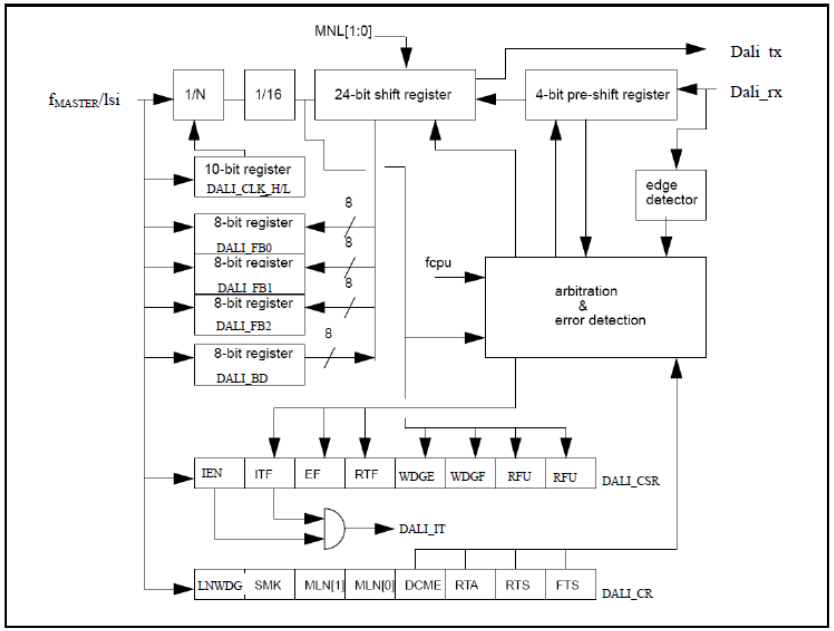
- 8 channels
- 10 bit resolution with gain (x1 or x4)
- 300 µV resolution (gain = x4)
- Conversion time: 2.4 µs (single mode), 3 µs (circular mode)
- Reference internally generated from the band-gap => independent on supply voltage => no need for very accurate voltage supply



Hardware DALI

Main features:

- Bi-phase Manchester asynchronous serial data format (6-9V)
- Programmable 1.2kHz, 2.4kHz and 4.8 kHz transmission rate (±10%)
- Bi-directional communications in four 8-bit forward/backward data registers
- Variable 16-18bit and 24 bit forward message length are supported
- 153.6Khz internal RC can be used in low power (standby) mode for Dali peripheral
- 500ms (±10%) interface failure detection to monitor receiver line timeout
- Maskable interrupt
- Dali_rx, Dali_tx polarity insensitive signal lines
- Configurable Noise Rejection Fitler
  - remove any RX bounce, glitch or spurious pulse



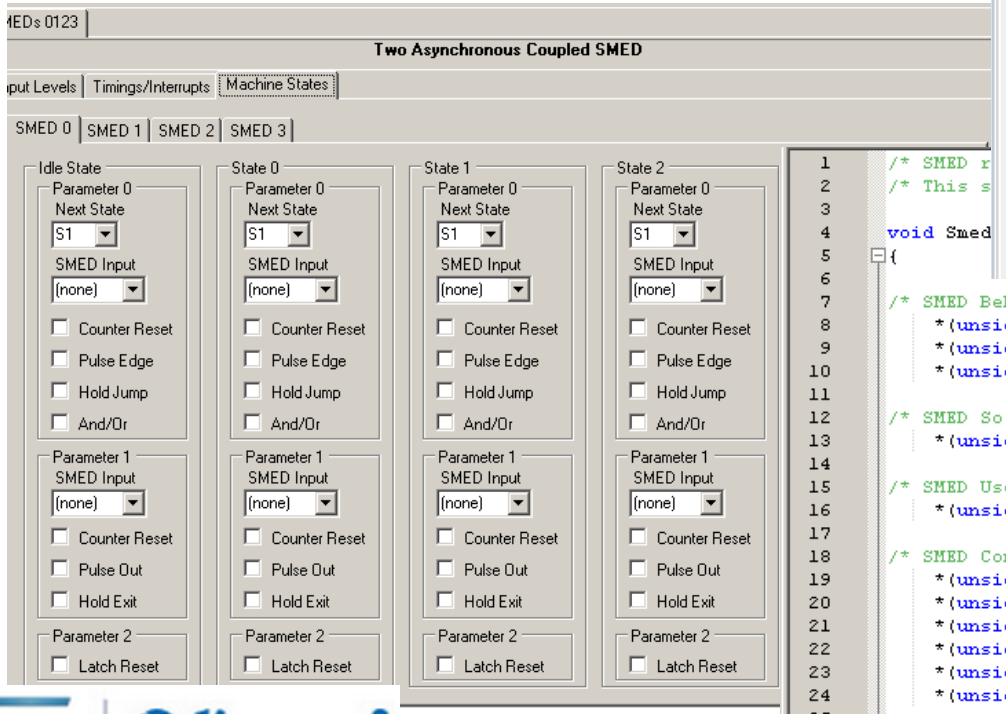
Standard references – IEC 62386 – xxx:

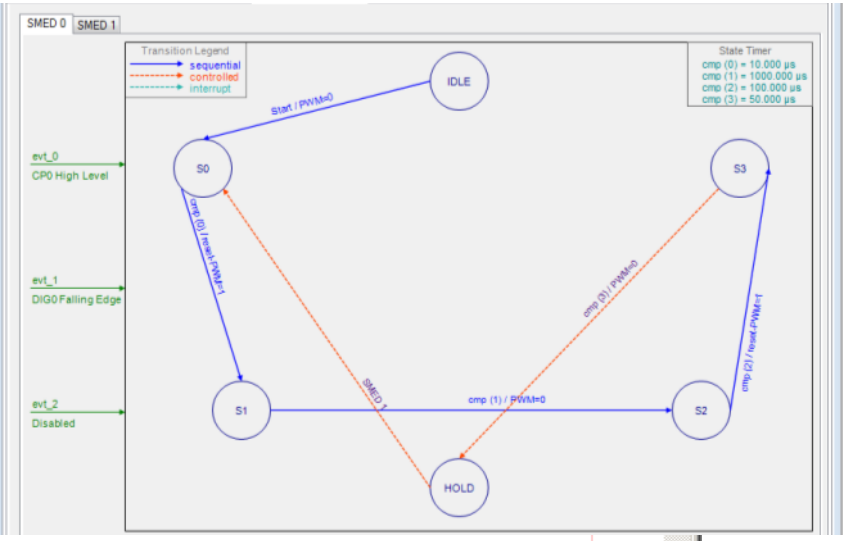
- **101 – general requirements of systems**
- **102 – general requirements of control gears**
- 201 – fluorescent lamps
- 202 – emergency lighting
- 203 – discharge lamp (not Fluorescent)
- **204 – LV Halogen**
- 205 – supply voltage for incandescent lamps
- 206 – Conversion from digital to DC voltage
- **207 – LED modules**
- 208 – Switching function (on/off devices ndr)
- **209 – Color LED**
- 210 – Sequencer

*** available**

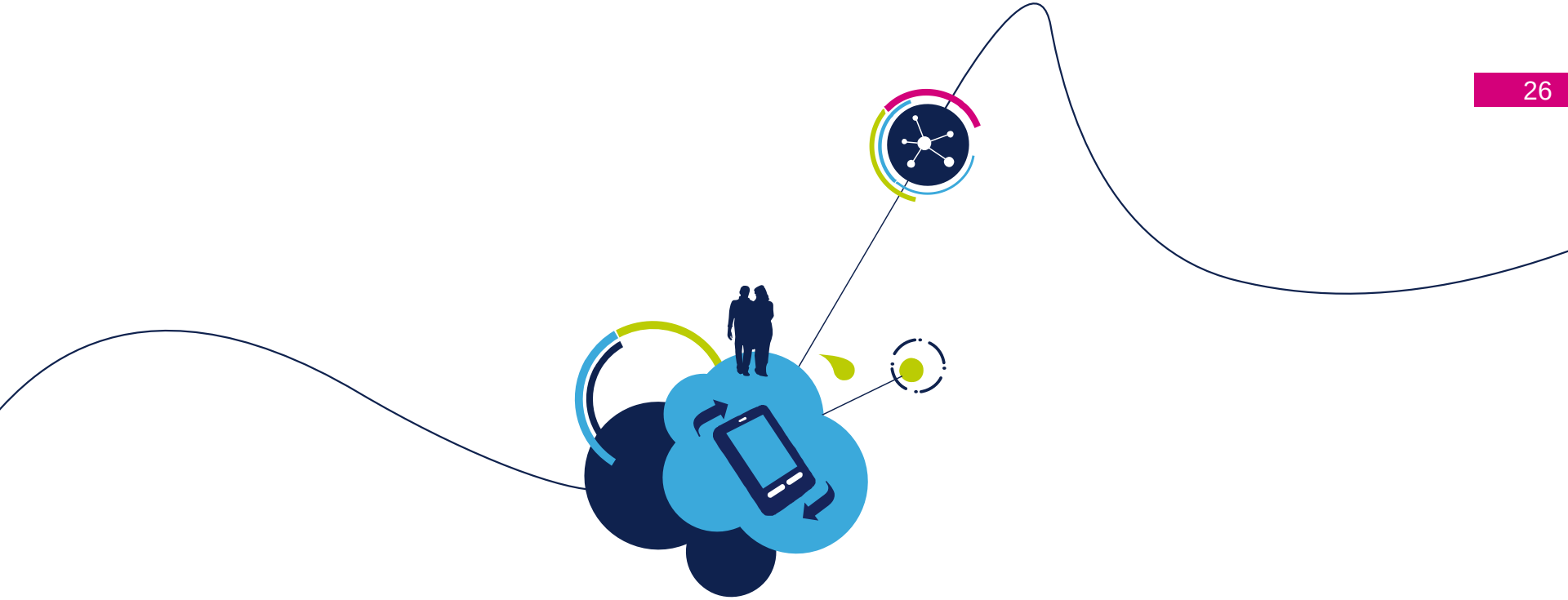
Visual PWM generation configurator

- Easy approach to SMED configuration
- Visual configuration of user applications
- Graphic state evolution visualization
- C code generation
- Import from real application for debug






```
1   /* SMED r
2   /* This s
3
4   void Smed
5   {
6
7   /* SMED Behavior registers */
8       *(unsigned char *)0x5025 = 0x66;     /* MSC_SMDCFG01 */
9       *(unsigned char *)0x5026 = 0x66;     /* MSC_SMDCFG23 */
10      *(unsigned char *)0x5027 = 0x00;     /* MSC_SMDCFG45 */
11
12  /* SMED Software Event register */
13      *(unsigned char *)0x5028 = 0x00;     /* MSC_SMSWEV */
14
15  /* SMED Use Unlock register */
16      *(unsigned char *)0x5029 = 0x00;     /* MSC_SMULOCK */
17
18  /* SMED Connection Box registers */
19      *(unsigned char *)0x502A = 0x00;     /* MSC_CBOXS0 */
20      *(unsigned char *)0x502B = 0x00;     /* MSC_CBOXS1 */
21      *(unsigned char *)0x502C = 0x00;     /* MSC_CBOXS2 */
22      *(unsigned char *)0x502D = 0x00;     /* MSC_CBOXS3 */
23      *(unsigned char *)0x502E = 0x00;     /* MSC_CBOXS4 */
24      *(unsigned char *)0x502F = 0x00;     /* MSC_CBOXS5 */
25
26  /* SMED Output Enable register */
27      *(unsigned char *)0x503B |= 0x00;    /* MSC_IOMXP1 */
```



Application Examples (tools)

TM Boost PFC converter 130W

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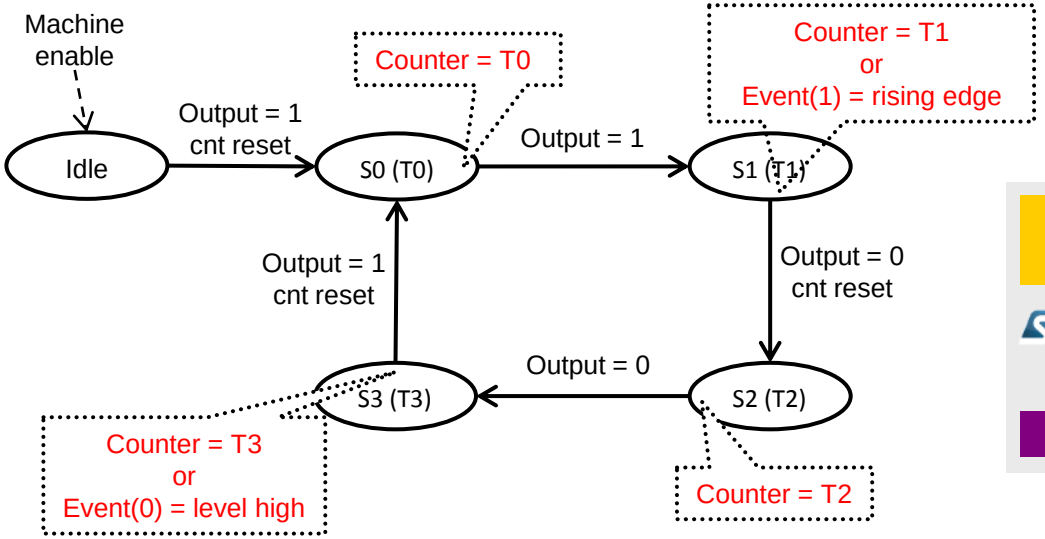
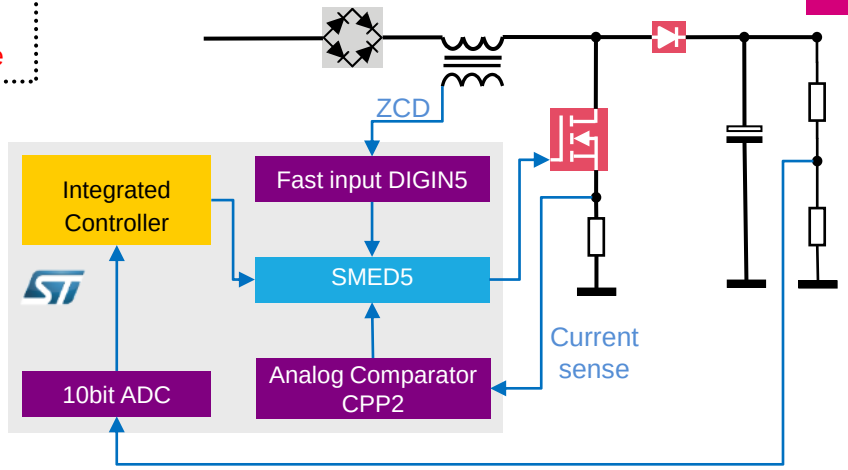
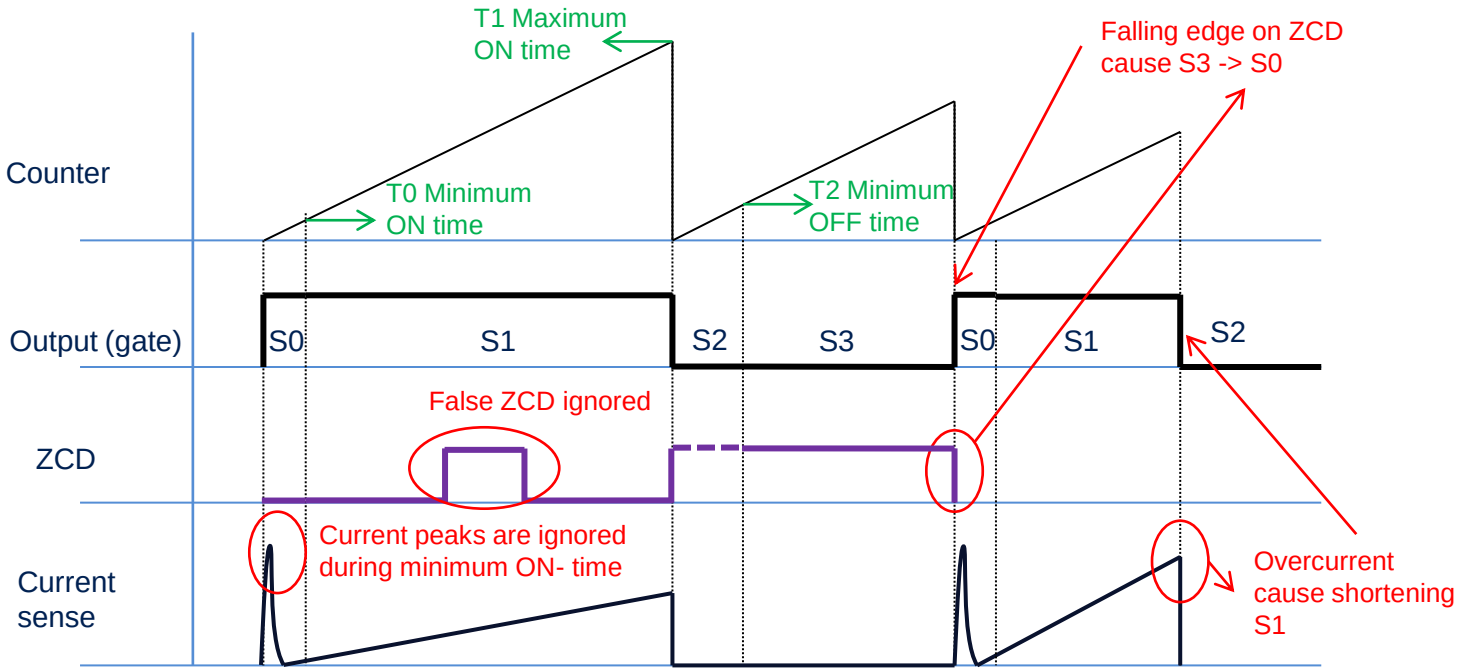
TM Boost PFC converter 130W

- Input universal range (90-265V)
- No-Load management
- Adaptive Start-up
- User Manual writing ongoing
- FINAL BOARD available

130W TM Boost PFC converter







120W Offline LED driver

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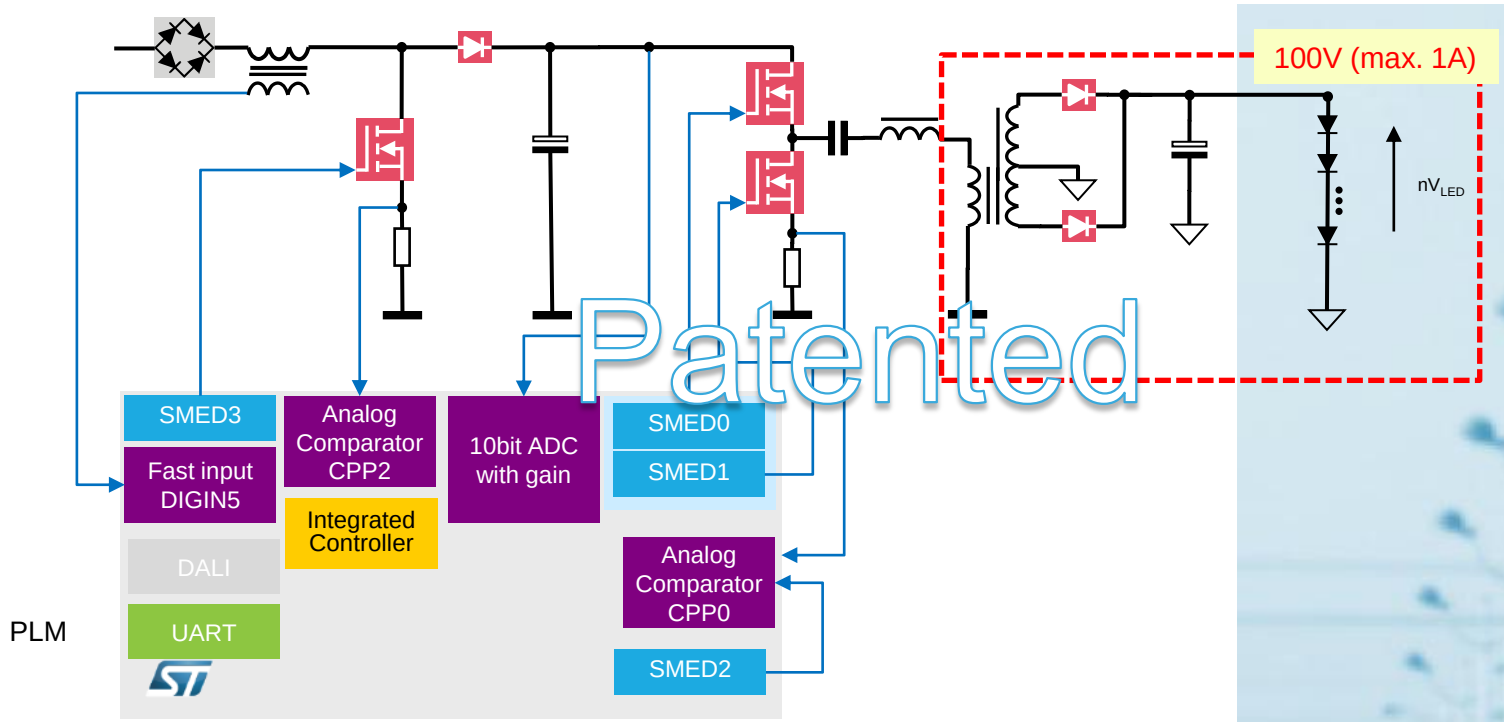
Offline PSR-ZVS 120W Street-lighting



- 120 W (100V Vout @ 1A) Single string LED driver
- PSR and dimming scheme, 10bit resolution (30%)
- Extremely high efficiency (>> 90%)
- Extremely accurate light regulation
- PWM digital dimming: >1kHz, 11bit (OPTIONAL)
- Communication: DALI, UART ctrl and setup (insulated) 0-10 for white version only (insulated)

Q4 2013

HARDWARE AND FIRMWARE UNDER DEVELOPMENT

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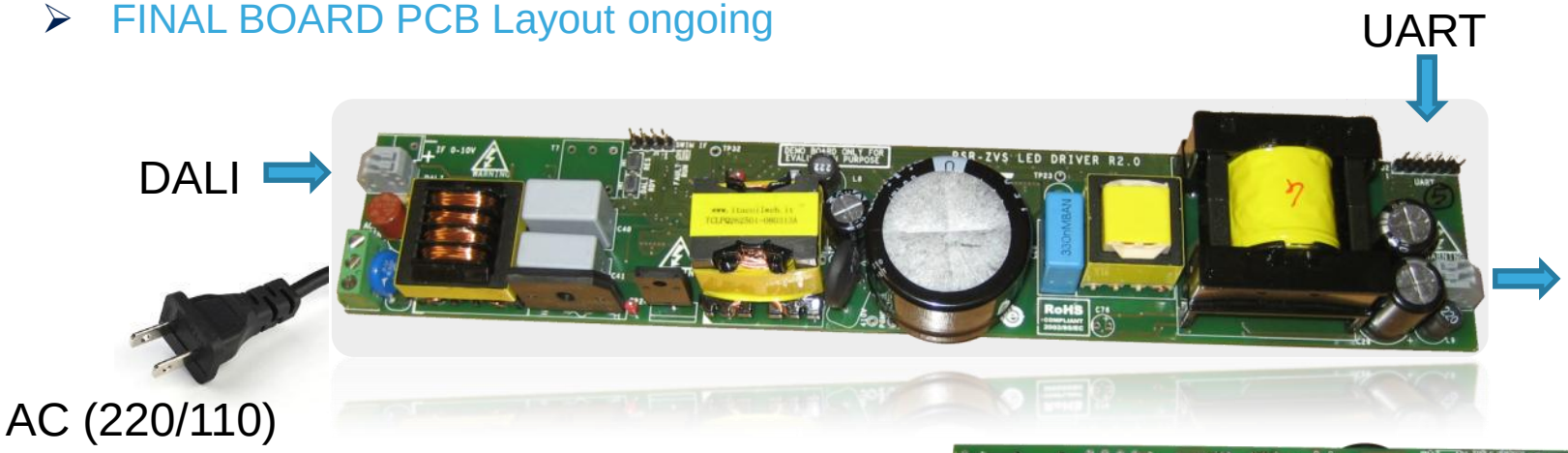
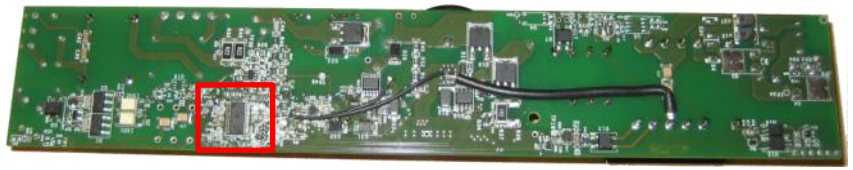
120W OFFLINE LED driver Single string

- PROTYPE: functional analysis successfully completed.
- Feature fine tuning ongoing
- DALI integration ongoing
- User Manual writing ongoing
- FINAL BOARD PCB Layout ongoing





STLUX385A

- Options
  - 1. Street-lighting 120W single string
  - 2. Steet-lighting / Office120W multi string
  - 3. RGB/White multi channel independently PWM dimmable with programmable full light level on discrete steps to adapt to specific Light module

LED Driver architectures

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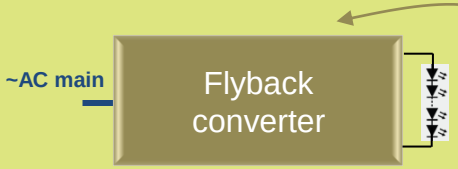
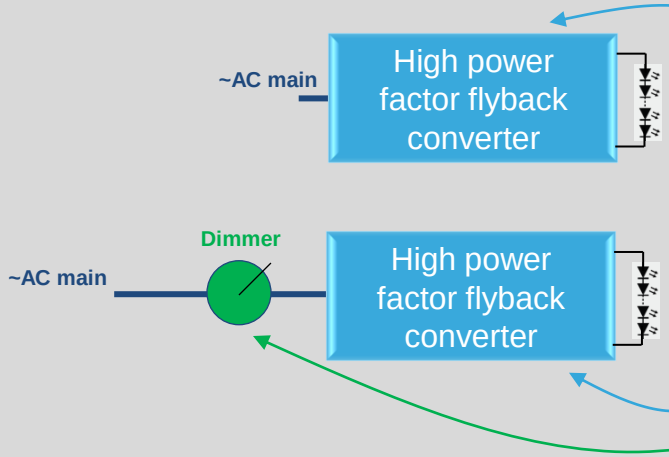
General illumination: architectures (1/3)

Up to 15W

General architecture up to 5W



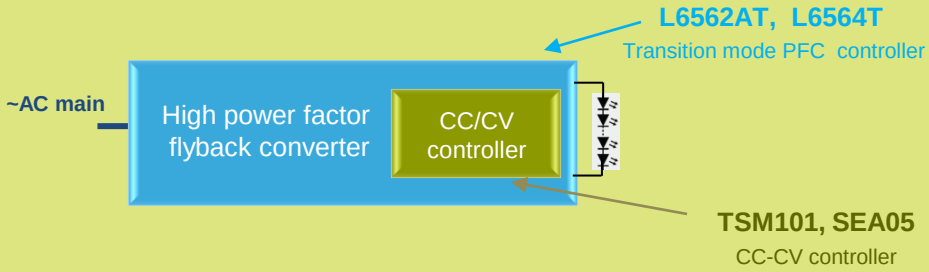
General architecture above 5W



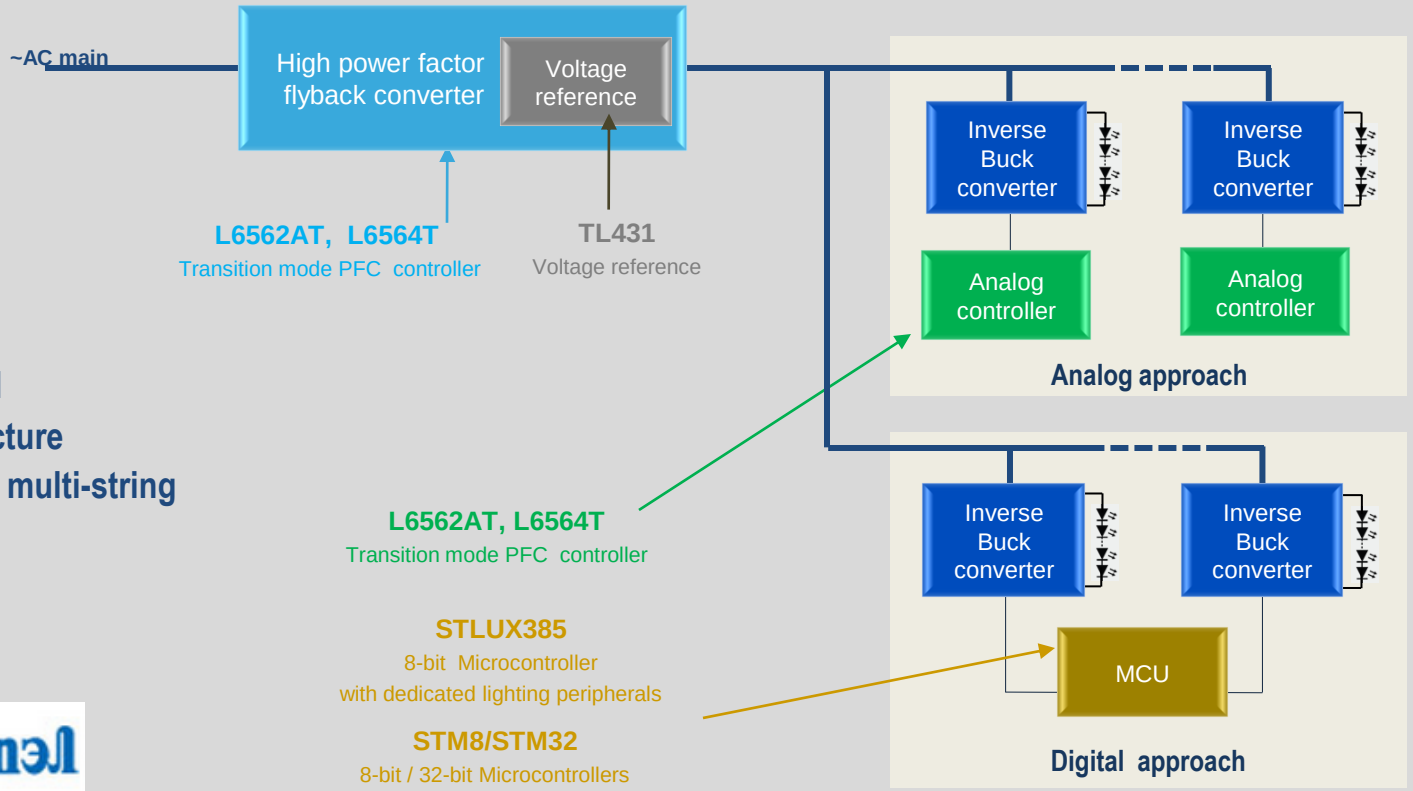
General illumination: architectures (2/3)

From 15W to 75W

General architecture for LED single string



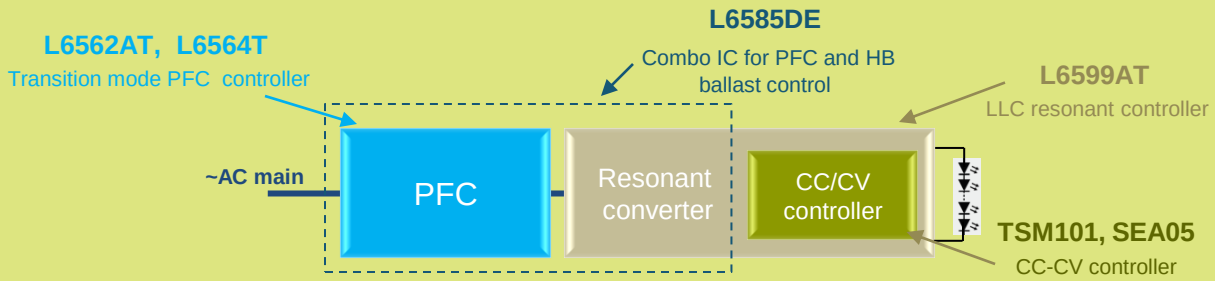
General architecture for LED multi-string



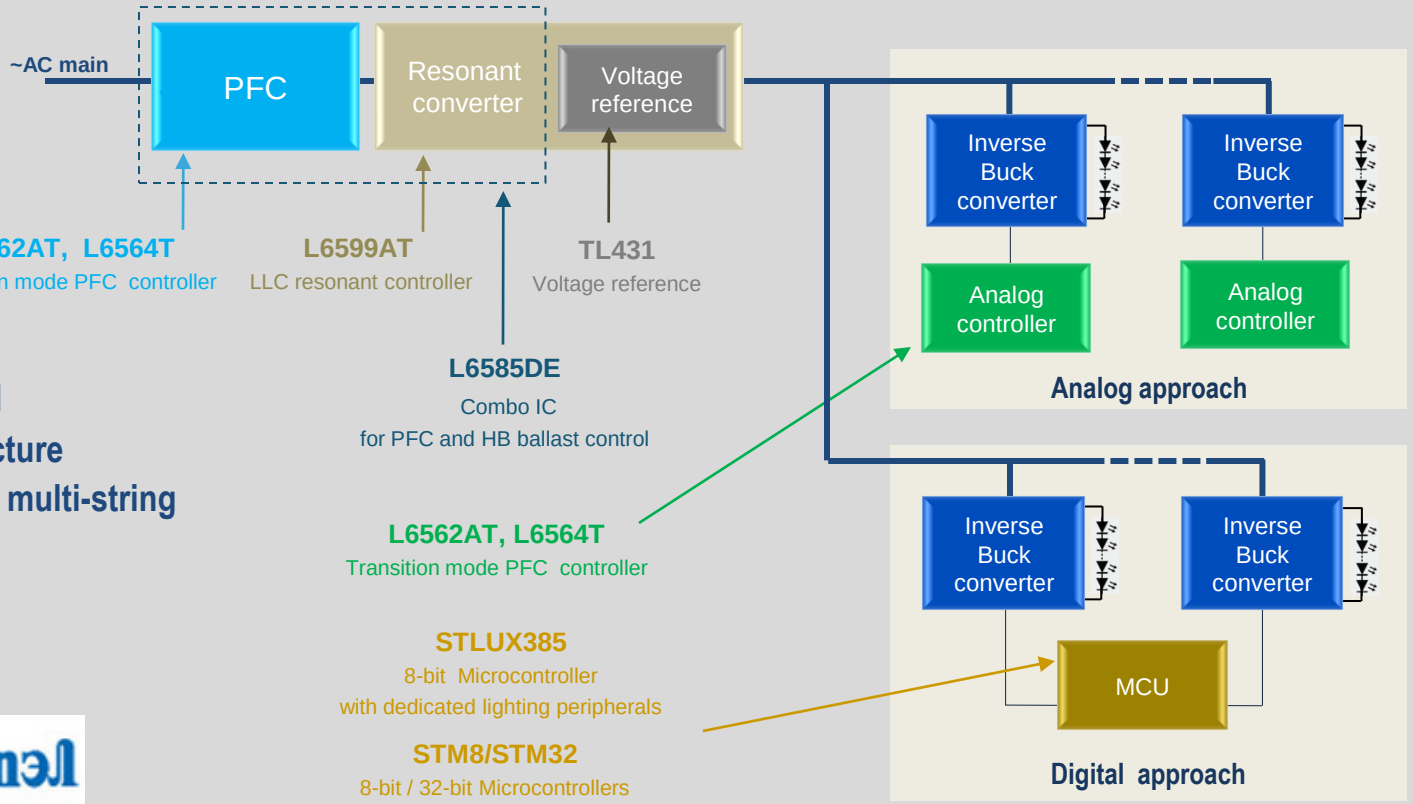
General illumination: architectures (3/3)

Above75W

General architecture for LED single string



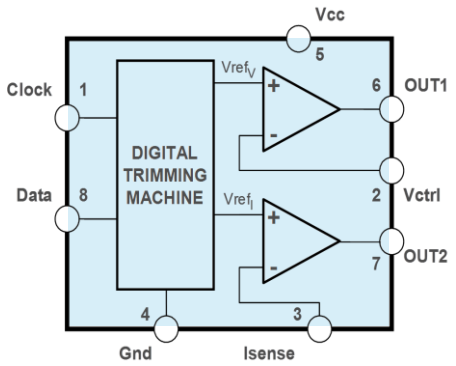
General architecture for LED multi-string

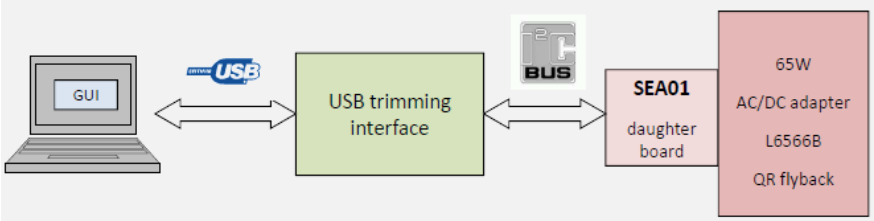


Analog companion IC

NEW SEA01 (*): digital CV/CC controller with on-line trimming

Device block diagram





AVAILABLE

Digital trimming toolkit

- PC GUI
- USB trimming interface
- SEA01 daughter board
- 65W mother board

Main features

- **Trimmable references for both loops**:
  - 5 bits for Vrefv and 5 bits for Vrefi adjust
  - Vrefv = 2.5V (0%) with 0.2% trimming step
  - Vrefi = 30 mV (0%) with 3.3% trimming step
- 2 times trimmable (redundand OTP)
- Simple & robust trimming protocol and storage
- 20 mA sink/source capability (OUT1-2, Iref)
- Wide operating Vcc range [3.5 – 36] V
- Low quiescent consumption: 200 µA
- SO8 package

Digital trimming characteristics

- **I2C slave interface**: **two programming pin Clock and Data**
- Parity check bit
- Non volatile memory (NVM) with redundant OTP (two OTP)
- Status register for NVM check and parity fail check
- Volatile memory for emulation
- Emulate/read/write/reload commands
- 100 Kbps max speed

On-line digital trimming for highest end-product accuracy: CV and CC control

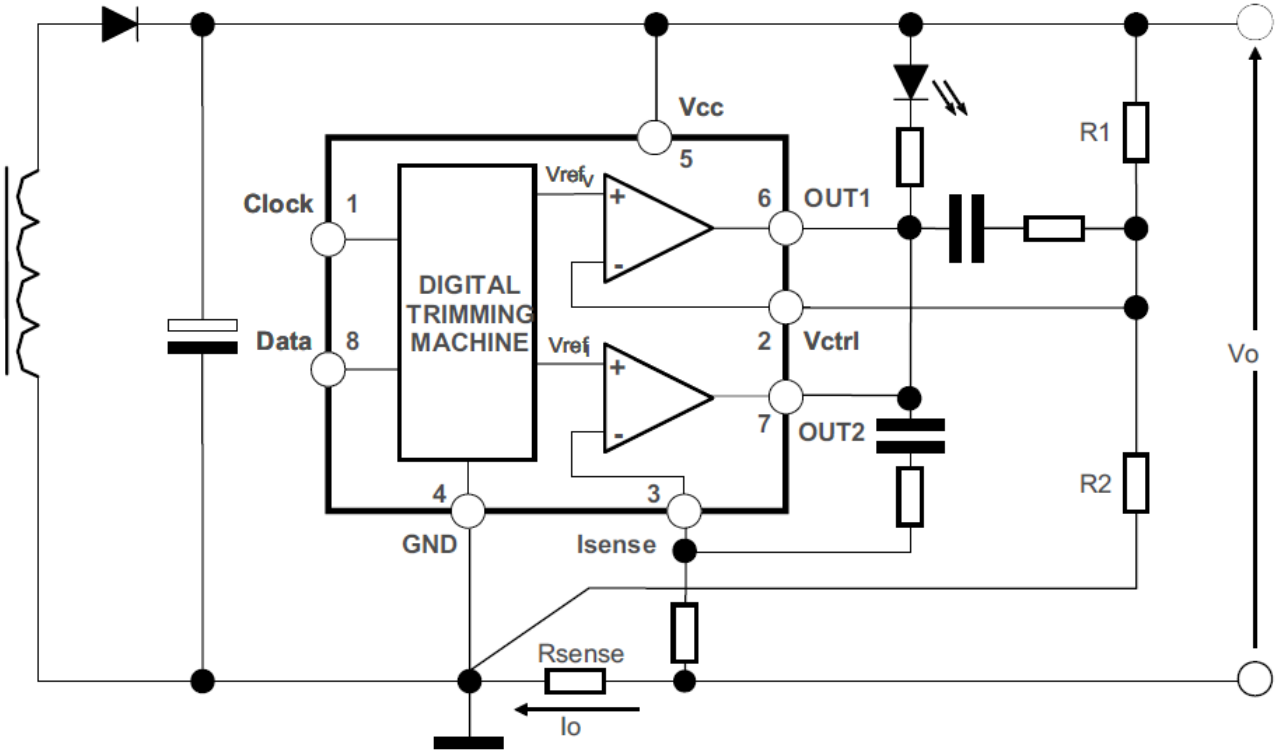
(*) Samples available

Analog companion IC

SEA01: digital CV/CC controller with on-line trimming

$$R1 = R2 \cdot \left(\frac{Vo}{Vref_v} - 1\right)$$

$$Rsense = \frac{Vref_I}{Io_{max}}$$



Systems LAB & Technical Marketing

DC/DC LED drivers

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General illumination: DC-DC LED drivers (1/2)

LED2000 (*) NEW

Monolithic buck LED driver with synchronous rectification

Main features

- Input voltage: **3V to 18V**
- Adjustable output current: **up to 3A**
- Switching frequency: **850kHz**
- PWM Dimming features
- ± 7% output current accuracy
- Integrated 70mΩ low side Rdson Mosfet (N-channel)
- Integrated 90mΩ high side Rdson mosfet (P-channel)
- FB voltage 100mV

LED2001 (*) NEW

Monolithic buck LED driver with synchronous rectification

Main features

- Input voltage: **3V to 18V**
- Adjustable output current: **up to 4A**
- Switching frequency: **850kHz**
- PWM Dimming features
- ± 7% output current accuracy
- Integrated 70mΩ low side Rdson mosfet (N-channel)
- Integrated 90mΩ high side Rdson mosfet (P-channel)
- FB voltage 100mV

LED5000 (**) NEW

Monolithic LED driver (buck, buck-boost, floating boost topologies supported)

Main features

- Input voltage: **5.5V to 48V**
- Adjustable output current: **up to 3A**
- Switching frequency: **850kHz**
- PWM Dimming features
- ± 3% output current accuracy
- 200 mΩ typical Rdson
- Sensing voltage 200mV

Emergency lighting

Flash light

MR16
Bulb replacement

(*) Samples available (**) Samples available in Q4 2012

life.augmented | Компэл

General illumination: DC-DC LED drivers (2/2)

LED6000 (**)

NEW

Monolithic LED driver (buck, buck-boost and floating boost topologies supported)

Main features

- Input voltage: **4.5V to 61V**
- Adjustable switching frequency: **250kHz to 1.5MHz**
- Adjustable output current: **up to 3A**
- PWM dimming
- 200 mΩ typical Rdson (N-channel mosfet)
- Sensing voltage 250mV

LED6001 (**)

NEW

LED driver (buck, buck-boost and sepic topologies supported)

Main features

- Input voltage: **4.4V to 40V**
- Up to 60V output voltage
- Adjustable switching frequency: **100kHz to 1MHz**
- PWM dimming with auxiliary series switch
- Analog dimming
- ± 4% output current accuracy
- Sensing voltage 30mV to 300mV
- Constant current control loop

STLDC08

Boost LED driver

Main features

- Input voltage range: **0.8 to 3.6 V**
- Optimized to operate from one or two NiCd/NiMH or alkaline cells
- Drives N-channel MOSFET or NPN bipolar transistor
- No control loop compensation required
- FET driver for very precise PWM dimming

MR16
Bulb replacement

Emergency lighting

Flash light

(*) Samples available (**) Samples available in Q4 2012

Systems LAB & Technical Marketing

Eval Boards

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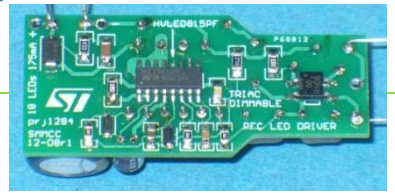
General illumination: solutions (1/4)

Up to 15W

NEW

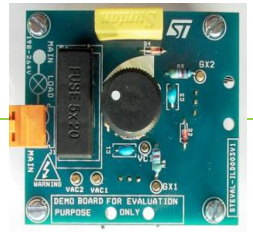
STEVAL-ILL044V1 (*), (**)
9 W Triac dimmable
LED power supply
based on HVLED815PF
HPF Flyback



- Vin = 90-132 Vac
- Iled = 175mA
- Voutmax =56V
- Power factor >0.98
- Efficiency >86%
- Dimmable over 90V to 132V range
- Isolated version (**)

AN4129, AN4130

STEVAL-ILD003V1 / V2
6W / 8W Home analog Light dimmer
based on TS820-600



- Suitable for LED & CFL retrofit & incandescent lamps
- 230 V – 50 Hz Line (V1 version), 120 V – 60 Hz Line (V2 version)
- Leading edge-control
- Control with potentiometer
- Dimmable LED lamps: 6W (V1 version), 8W (V2 version)
- Dimmable 14W CFL lamps

UM1512

UM1513

EVALHVLED805
4.2 W LED power supply
based on HVLED805
Flyback

- Vin = 185-230 Vac
- Iled = 350mA
- Voutmax =12V
- Output current ripple < 10%
- Average efficiency >70%

Data brief

STEVAL – ILL037V1
3.2 W LED power supply
based on HVLED805
Flyback

- Vin = 90-265 Vac
- Iled = 200mA
- Voutmax =16V
- Efficiency = 85%

AN3360

(*) Available in Q4 2012 (**) Not isolated version available STEVAL-ILL045V1

General illumination: solutions (2/4)

From 15W to 75W

NEW

EVAL6564-50WFLB (*)
50W Power supply
based on L6564T
HPF Flyback

- Vin = 90-265 Vac
- Iout = 2.1A
- Voutmax = 24Vdc
- Efficiency = 88%
- PF > 0.9
- Max 2fl output ripple= 1.1 Vpk-pk (Vin=230V, Pout 50W)

AN draft (*)

Up to 15W

NEW

EVALHVLED815 (*)
10.2 W LED power supply
based on HVLED815PF
HPF Flyback

- Vin = 185-265 Vac
- Iled = 340mA
- Vout = 30V
- Power factor = 0.92
- Average efficiency 86%

AN draft (*)

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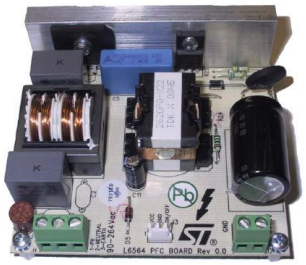
Компэл

(*) Available in Q4 2012

General illumination: solutions (3/4)

Above 75W

EVL6564-100W
100W Transition mode
PFC pre-regulator
based on L6564



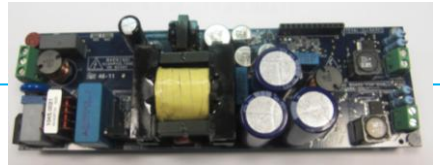
- Vin = 90-265 Vac
- Regulated Vout= 400 Vdc
- Max efficiency =97.5%
- PF=0.99
- THD<6%

AN3022

From 15W to 75W

NEW

STEVAL-ILL043V1 (*)
75W Two independent
LED strings power supply
based on L6562A
HPF Flyback
+ 2 inverse buck converter

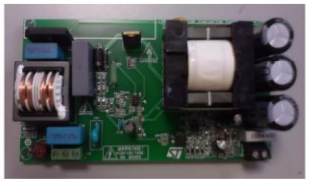


- Vin = 185-265 Vac
- Iled = 700mA
- Voutmax = 65Vdc
- Efficiency > 92%
- PF = 0.96
- Independent LED string dimming
- Remote turn-on / turn-off

AN draft (*)

NEW

STEVAL-ILL042V1 (*)
60W LED power supply
based on L6562A and TSM101
HPF Flyback



- Vin = 185-265 Vac
- Iled = from 350mA to 500mA
- Voutmax = 130Vdc
- Efficiency > 92%
- PF > 0.95

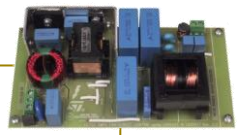
AN3424

(*) Available in Q4 2012

General illumination: solutions (4/4)

Above 75W

EVL130W-STRLIG
130 W power supply
based on L6562A and L6599
PFC circuit + Resonant converter



AN3106

Digital approach

STEVAL-ILL031V1
120W Digital constant current
LED driver based on STM8S208x
4 Inverse buck converters

AN3151

Analog approach

EVL6562A-LED
16.8 W Analog constant current
LED driver based on L6562A
Inverse buck converter

AN2983, AN2828

STEVAL – ILL038V1
100 W power supply
based on L6585DE
PFC circuit + Resonant converter

AN3407

EVL6562A-LED
16.8 W Analog constant current
LED driver based on L6562A
Inverse buck converter

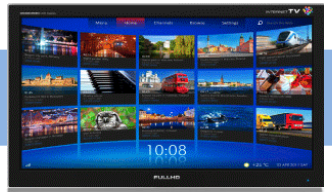
AN2983, AN2828

LED lighting by applications

General illumination

- Residential lighting
- Commercial lighting
- Architectural lighting
- Street lighting
- Large area illumination
- Emergency lighting

Consumer



- Notebooks, Netbooks
- Mid to large sized LCDs, LED TVs
- PDAs, MP3/PMP,
- Mobile, Smartphones
- Digital cameras
- Video game consoles
- General backlighting

Display and signage

- Stadium display
- Advertising display
- Video wall
- Traffic lights, road signs
- Transportation/ information display

Vehicle

- Interior lighting
- Exterior lighting
- Infotainment display backlighting

LED lighting by applications

General illumination

- Residential lighting
- Commercial lighting
- Architectural lighting
- Street lighting
- Large area illumination
- Emergency lighting

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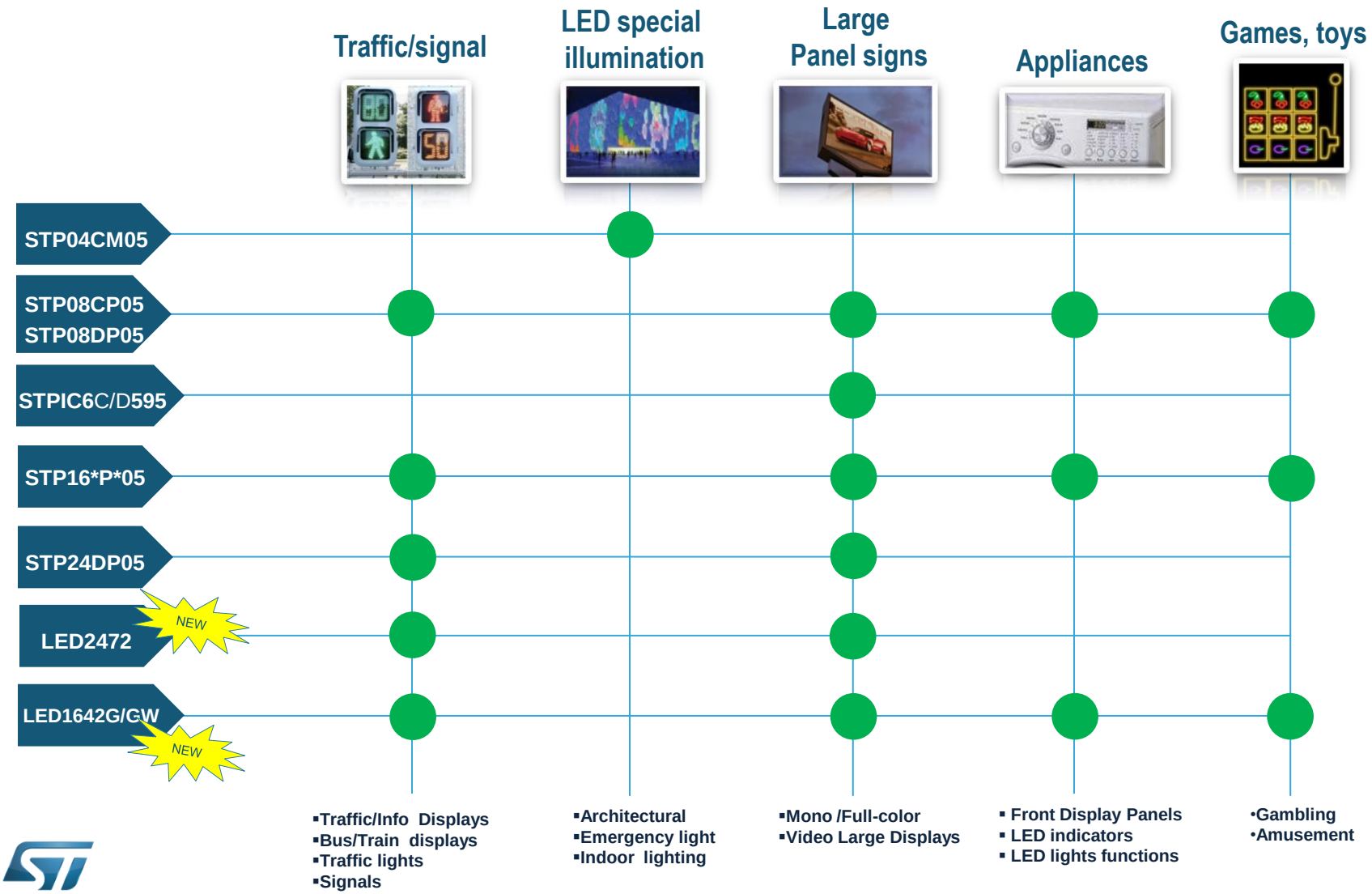
- Interior lighting
- Exterior lighting
- Infotainment display backlighting

Display and signage: LED array drivers (1/2)



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* is used as a wildcard character for related part number

Display and signage: LED array drivers (2/2)

STP04CM05

- 4 channels, 80-400mA
- Adjustable output current using a single external resistor
- 20V output driving capability
- Serial data IN / parallel data OUT
- Thermal shut-down

STP08CP05
STP08DP05

- 8 channels, 5-100mA
- Adjustable output current through external resistor
- Serial data IN / parallel data OUT
- Thermal shut-down
- Short and open output error detection

STPIC6C/D595

- 8 –bit shift register with DMOS O/Ps LED driver
- Serial dataI/P, parallel data O/P
- Io=120mA (D), 100mA (C)
- Vled= 20V (D), 33V (C)

STP16*P*05

- 16 channels, 5-100mA
- Adjustable output current through external resistor
- Short and open output error detection
- Auto Shut-Down
- Balanced output rise/fall time
- Serial data IN / parallel data OUT

STP24DP05

- 8 x 3 Channel groups of constant current output channels, 5-80mA
- Adjustable output current through one external resistor for each group of 8-channel
- Output gradual delay (typ. 30ns for each group)
- Short and Open Output Error Detection
- Serial Data IN / Parallel Data OUT
- Thermal shut-down

NEW

LED2472 (**)

- 24 channels,3 groups (**RGB**) of 8 constant current LED sink drivers
- Output current from 4mA to 72mA
- Current set through a single external resistor for all groups and separately adjustable for each color by a 6bit gain register into two sub-ranges (64steps per range)
- LED fault detection (open and short conditions)
- Auto Power Shutdown and Auto Wake-Up
- Output gradual delay (typ. 10ns)
- SDO synchronization on the falling edge of the clock signal
- Thermal shutdown and overtemperature alert through serial interface

NEW

LED1642G/GW (**)

- 16 channels, 3-36mA
- Normal and Stealthy error detection for open and shorted circuit LED (only for ***G*** series)
- Normal error detection for open and shorted circuit LED (only for ***GW*** series)
- Programmable shorted LED detection thresholds
- Current programmable through external resistor
- 7 bits global current gain adjustments in two ranges
- 12/16 bit PWM Grayscale Brightness control (only for ***GW*** series)
- Programmable output turn on/off time
- Selectable SDO synchronization on the CLK falling edge
- Auto power saving/auto wake up
- Gradual output delay (selectable)
- Thermal shut-down and overtemperature alert

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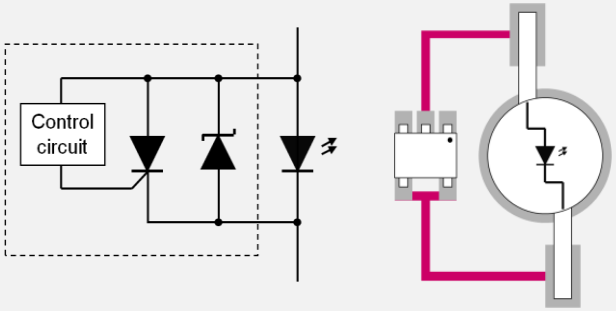
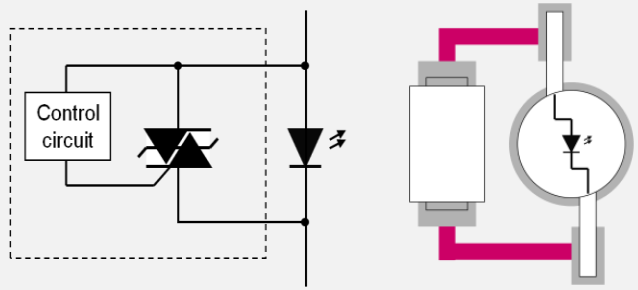
* is used as a wildcard character for related part number, (**) Samples available in Q4/12

Display and signage: LED by-pass diode



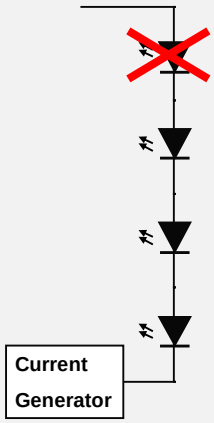
LBP01-0803SC5

350 mA LED bypass

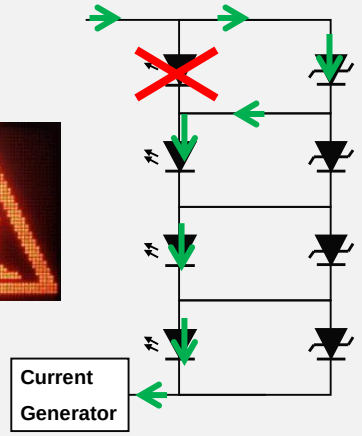


LBP01-0810B

1 A LED bypass



Without LED by-pass protection



With LED by-pass protection

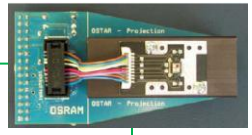
Display and signage: solutions (1/2)

STEVAL-ILL009V5
New RGB LEDs color demonstration board based on the STP04CM05, STP08CP05 and ST1S10

AN2531

STEVAL–ILL009V3
OSRAM OSTAR projection LEDs (8x350mA) board

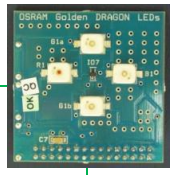
8 RGB LEDs



Data brief

STEVAL–ILL009V4
OSRAM Golden DRAGON LEDs (4x700mA) board

4 RGB LEDs



Data brief

STEVAL-ILL002V3 / V4
High brightness LED driver with diagnostics demonstration board based on the STP08DP05

5x8 LEDs

- Brightness regulation
- Blinking Speed regulation
- Animated Text
- Graphic user interface (GUI)
- DC-DC converter

AN2415

AN2478

Display and signage: solutions (2/2)

STEVAL-ILL024V1 / STEVAL-ILL025V1
Master/Slave boards for LED display
based on STP16DP05 LED matrix driver and
STM32F103 microcontroller

16x32 LEDs

- Keyboard interface for display data configuration
- MicroSD card interface for data storage
- GPS Interface
- 16x32 LED matrix display

UM0767

STEVAL-ILL003V2
High-brightness LED driver
without diagnostic demonstration board
based on STP16CP05

4x8 LEDs

- 32 LED matrix
- Adjustable brightness
- Adjustable blinking speed
- Animated text capability
- DC-DC converter for high efficiency

AN2141

STEVAL-ILL015V1
RGB LED array with LED error
detection board based on the
STP24DP05 and STM32

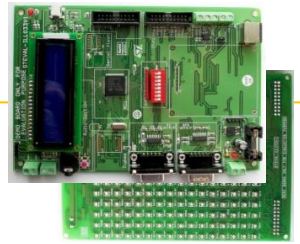
16 RGB LEDs

- Adjustable brightness and color of each LEDs
- JTAG interface for C firmware update
- Mini USB connector for PC GUI
- GUI software for LED diagnostic
- Error Detection Feature

UM0574

STEVAL-ILL033V1 / STEVAL-ILL032V1
Master/Slave
RGB LED matrix demo boards
based on STP24DP05 and STM32

16x16 RGB LEDs



- Control unit with PS2 keyboard interface for data entry
- Control unit with LCD which displays text and background color options
- 3 config mode: data entry, audio playback or demonstration

UM1449

LED lighting by applications

General illumination

- Residential lighting
- Commercial lighting
- Architectural lighting
- Street lighting
- Large area illumination
- Emergency lighting

Consumer

- Notebooks, Netbooks
- Mid to large sized LCDs, LED TVs
- PDAs, MP3/PMP,
- Mobile, Smartphones
- Digital cameras
- Video game consoles
- General backlighting

Display and signage

- Stadium display
- Advertising display
- Video wall
- Traffic lights, road signs
- Transportation/ information display

Vehicle

- Interior lighting
- Exterior lighting
- Infotainment display backlighting

Vehicle, interior lighting: LED drivers

ST provides a complete solution for automotive interior LED lighting and backlighting

- Accurate and compact for very small form factor applications
- High reliability and robustness (AEC-Q100 qualified)
- High efficiency
- Complete and flexible fault management
- Extremely high dimming performance
- Input voltage range up to 36 V

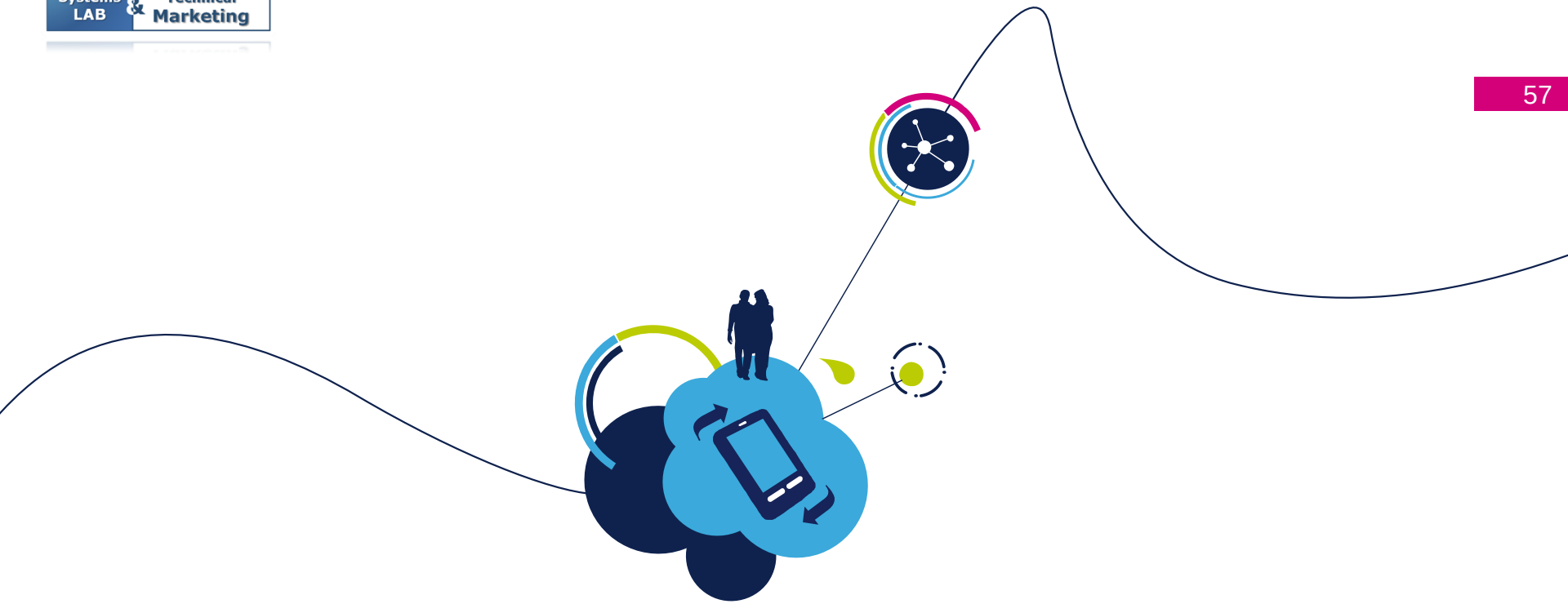
* is used as a wildcard character for related part number,

Vehicle, exterior lighting: LED drivers

ST provides a complete solution for automotive exterior LED lighting, DTRL, tail and turn lights

- Accurate and compact for very small form factor applications
- High reliability and robustness (AEC-Q100 qualified)
- High efficiency and complete fault management
- High-performance LED drivers with integrated diagnostic functions
- Extremely high dimming performance
- Input voltage range up to 61 V

* is used as a wildcard character for related part number,



Communication in LED lighting

Communication in LED lighting

DALI

Wireless communication

RF ZigBee ®

RF Sub-GHz

Power line communication

DMX

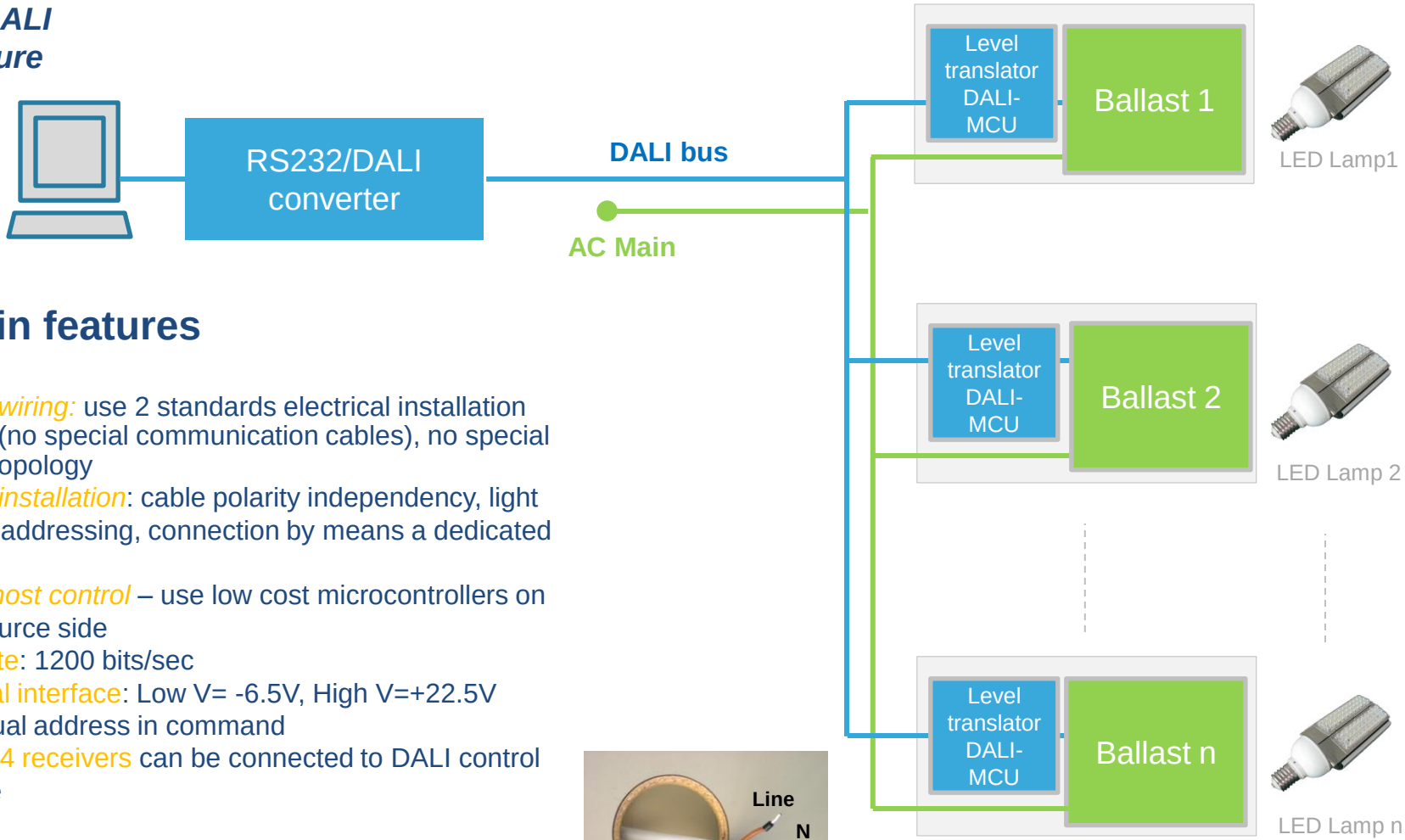
Home & public building lighting applications

Smart Street Lighting

Theaters, stage lighting & architectural / fashion lighting

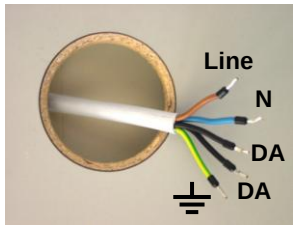
Communication in LED lighting: DALI

Typical DALI architecture



DALI main features

- *simple wiring:* use 2 standards electrical installation cables (no special communication cables), no special wiring topology
- *simple installation*: cable polarity independency, light source addressing, connection by means a dedicated BUS
- *digital host control* – use low cost microcontrollers on light source side
- data rate: 1200 bits/sec
- physical interface: Low V= -6.5V, High V=+22.5V
- Individual address in command
- Up to 64 receivers can be connected to DALI control module

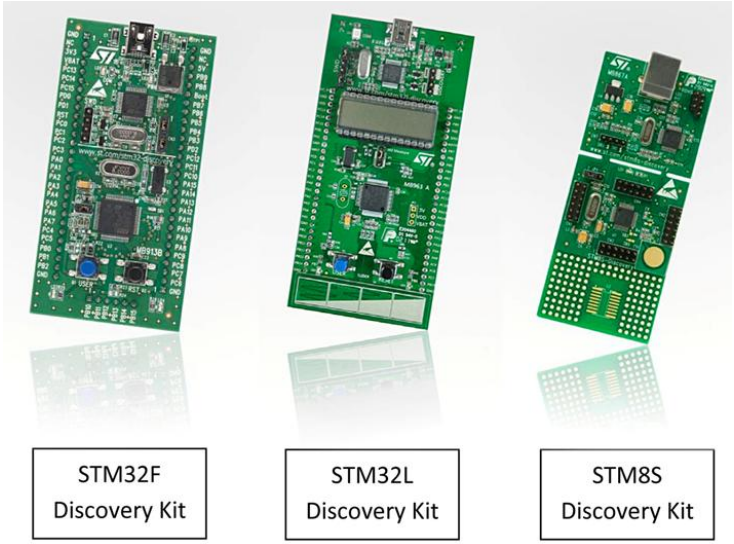


Example of DALI wiring

DALI implementation into ST MCU

Software emulation of DALI bus + additional DALI stack = **DALI library**

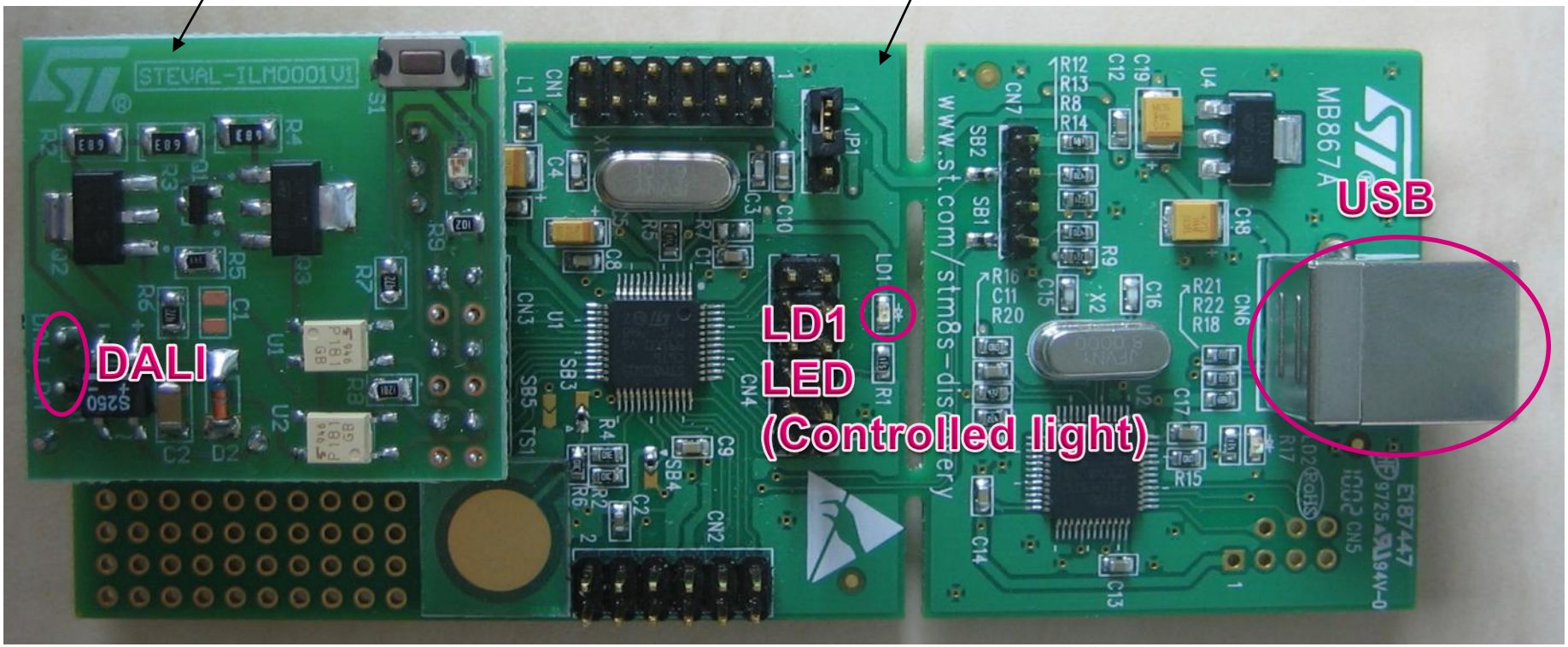
- IO pin driver
  - Physical and link layer of DALI interface (bit timing, bus error recovery control, DALI frames transmission/reception)
  - Occupied resources:
    - 2 GPIO pins – selectable (RX and TX) + 1 GPIO interrupt
    - 1 Timer (DALI protocol timing) + 1 Timer interrupt
- DALI stack layer
  - DALI commands implementation
  - HW independent
- Main user application
  - Example for STM8S-Discovery
  - Example for STM32-Discovery
  - Example for STM32L-Discovery



Hardware Connection for DALI (1/2)

STEVAL-ILM001

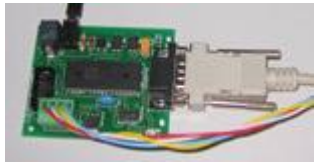
STM8S-DISCOVERY kit

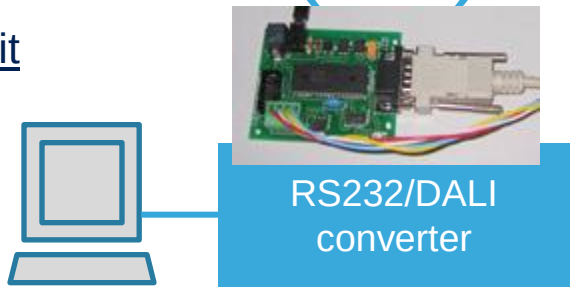


Similarly STM32/ STM32L Discovery kit can be connected to DALI bus using STEVAL-ILM001

Hardware Connection for DALI (2/2)

- Order the STEVAL-ILM001 board and STMxx-DISCOVERY kit
- Get the a DALI master module
  - ST7DALI kit (link)

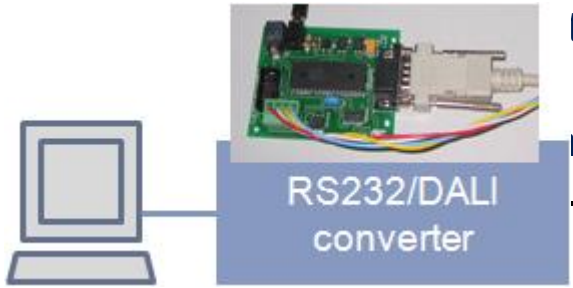




- Program STMxx-DISCOVERY with an example

the DALI bus and module to STMxx-DISCOVERY

s “a lamp” through DALI



DALI master

ST MCU DALI library – Implementation

1. IO pin driver routines (physical layer)
   - Direct pin control
   - Interrupt driven reception and transmission (GPIO pins, timer)
   - API functions:
     - Global initialization
     - Callback function initialization (called if DALI frame received)
     - Transmit function (called if DALI frame to transmit)

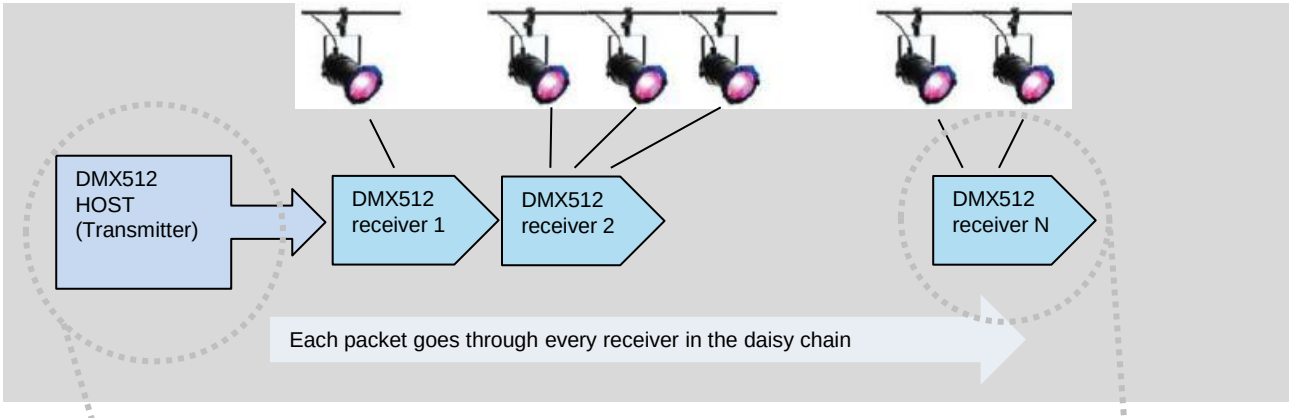
2. DALI stack routines
   - DALI commands processing (called from physical layer)
     - Required DALI commands according DALI specification
   - API functions :
     - Initialization of DALI stack and callback function for light control
     - Set of functions for error/failure status check

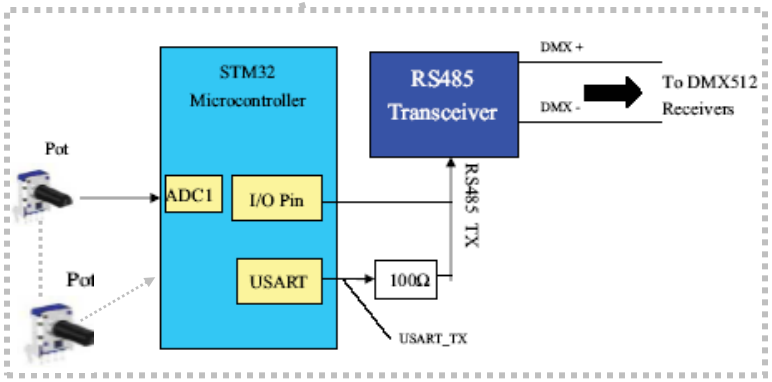
3. Customer firmware Example
   - Implementation of callback functions for light control:
     - Depends on given light control principle
     - Peripherals control for given control (PWM, ADC, DAC, ...)
   - Lower layers initialization: IO pin driver, DALI stack
   - Calls API functions (transmit, error management, status check functions, ...)
   - Implements another customer application details (e.g. LED status, failure notification, power management, ...)

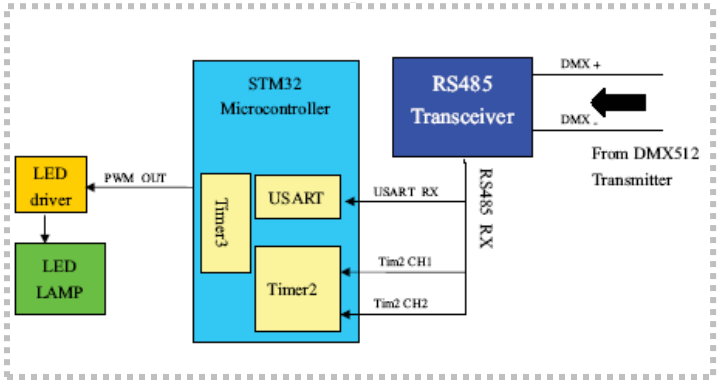
Communication in LED lighting: DMX

DMX = Digital MultipleX

Typical DMX512 architecture





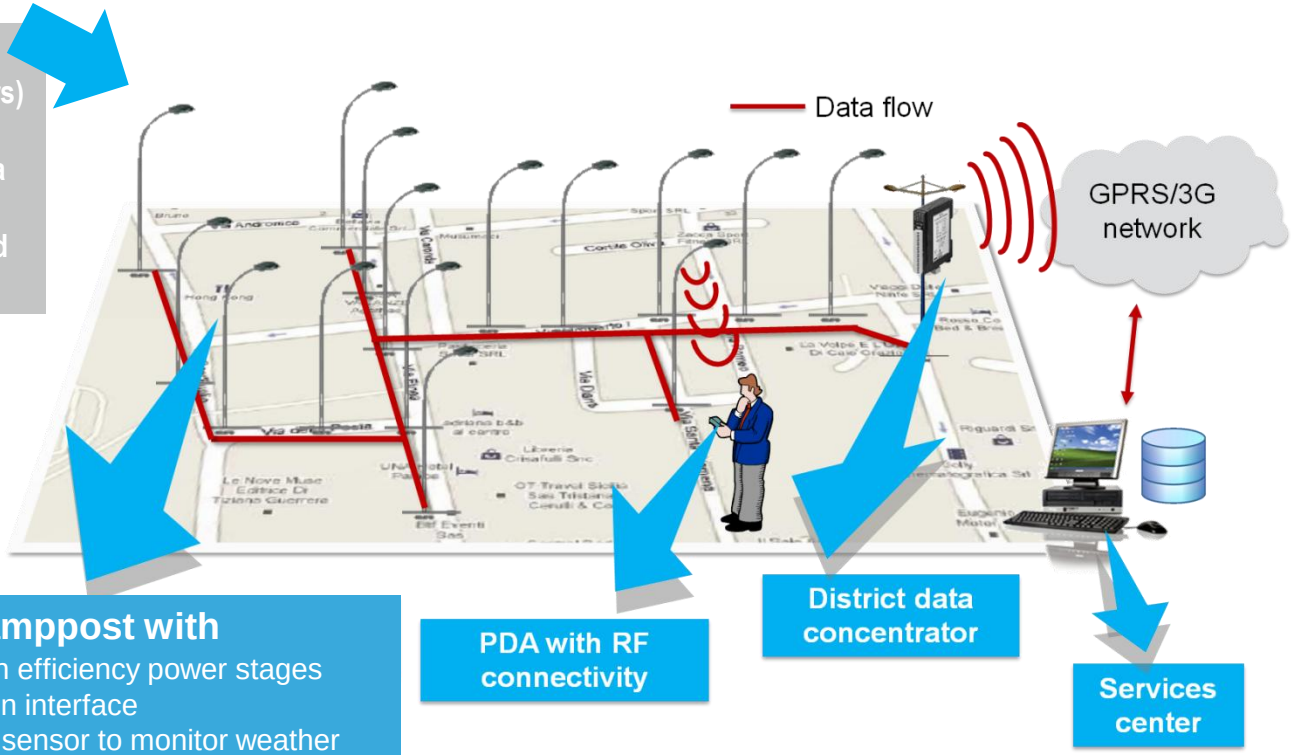


DMX512 Main features

- Up to 512 receivers can be connected to the DMX host
- Daisy chain connection
- Physical interface: 3 to 5 wires
- Data rate: 250 kbits/sec

Communication in Smart Street Lighting

Each ***lamppost*** provides lighting data
(by means power line or wireless transceivers)
to a ***district concentrator***
that manages and transmits the relevant data
(often via a digital cell phone modem)
to a secure ***server*** that captures the data and
presents it in a web-browser interface


Data flow
GPRS/3G network
Lamppost with
- Advanced high efficiency power stages
- Communication interface
- Various smart sensor to monitor weather conditions, lamppost inclination and air pollution
PDA with RF connectivity
District data concentrator
Services center

The bi-directional communication allows the complete remote control of the lamps

Dimming level
Adjust On/off timing
Lamp failure
Pole tilt
Energy consumption

Communication in LED lighting: microcontrollers (1/3)

STLUX385 (*)

NEW

The 8-bit microcontroller tailored for lighting applications

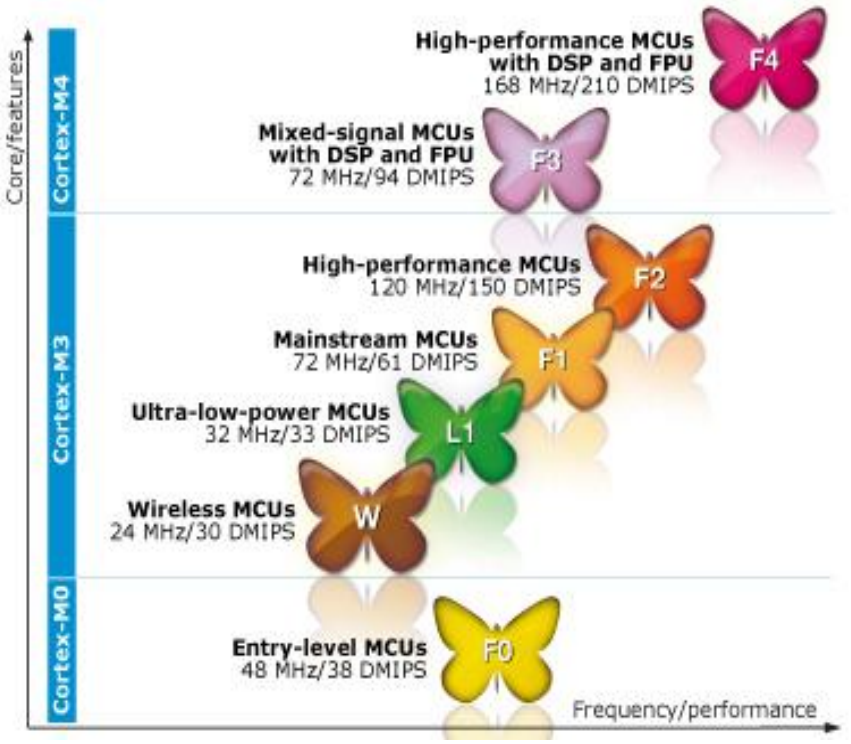
Special features

- 6 SMEDs (State Machine Event Driven) independent PWM programmable pulse signal generators
- Fast analog comparators (50ns max propagation delay)
- 96MHz PLL for high output signals resolution
- 10 bit, 8 multiplexed channels ADC with operation amplifier to extend resolution to 12 bit
- DALI hardware communication cell

Suited to manage DALI protocol and street lighting communication

STM32

The 32-bit microcontroller family



Suited to manage DMX, DALI protocols and street lighting communication

(*) Engineering samples available

life.augmented

Communication in LED lighting: wireless MCUs and transceivers (2/3)

STM32W ARM CORTEX-M3

IEEE 802.15.4 wireless system-on-chip

Integrated 2.4 GHz radio MCU enables efficient and low cost wireless network implementation

- IEEE 802.15.4, 2.4 GHz best in class radio performance
- Fits most popular protocol stacks: ZigBee, RF4CE, 6LoWPAN and more
- Open32-bit platform providing standardized IEEE802.15.4 MAC interface for specific protocol stacks or future stack evolutions such as IP based
- Configurable I/Os, ADC, timers, SPI, UART
- Wide ARM Cortex-M3 tools based offering

SPIRIT1

Sub-GHz transceiver

Low Power RF Transceiver, intended for RF application in the sub-1GHz Band

- Frequency bands: 169, 315, 433, 868, 915 MHz
- Extremely low power consumption [9mA RX, 21mA TX @ +11dBm]
- Programmable channel spacing (12.5 kHz min), complying with the EN300 220 standard
- Main operating parameters controlled via SPI interface
- Integrated SMPS allowing very Low Power Consumption
- Configurable data rate from 1 to 500 kbps

Suited for wireless communication

Communication in LED lighting: power line transceivers(3/3)

ST7540 Power line transceiver

The highly compact and cost effective solution for narrowband power line communication

- Half duplex binary FSK transceiver
- 8 programmable communication frequencies
- Programmable baud from 600 to 4800 bps
- Integrated single ended line driver
- Freezable power amplifier output level
- Tunable output active filtering
- Integrated 5 V, 50 mA linear voltage regulator
- Integrated 3.3 V, 50 mA linear voltage regulator
- Secure access 48 bit control register
- Programmable carrier and preamble detection
- Programmable band in use detection
- Programmable header and frame length recognition
- Watchdog timer
- SPI/UART microcontroller interfacing
- Very low power consumption (Iq=3.5 mA)
- Very high sensitivity (0.25 mV RMS)
- Compliant with CENELEC EN50065 and FCC part
- 15 regulatory specifications

STarGRID power-line networking SoC platform

STarGRID product family

ST7570, ST7580, ST7590

- Fully-integrated narrowband power-line networking system-on-chip
- High-performance DSP with embedded programmable turnkey firmware for multiple-modulation management
- Convolutional correction coding
- Programmable bit rates up to 128 Kbit/s
- Channel quality estimation
- Host UART/SPI controller
- I2C/SPI external data memory interface
- High-speed memory controller for optional code execution from external memory
- Watchdog timer
- On-chip 128-bit AES encryption HW block
- Fully integrated analog front end
- High-sensitivity receiver
- High-linearity transmitter

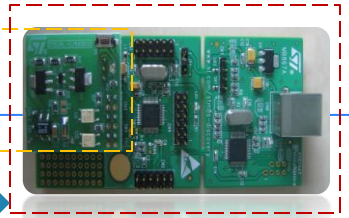
Suited for wired communication

Communication in LED lighting: solutions (1/2)

DALI

STEVAL–ILM001V1
DALI communication interface

STM8S/STM32F Discovery kit



- Provides all the functions required by the DALI standards
- STM8S/STM32F-DISCOVERY + STEVAL-ILM001V1 working as a DALI slave
- Suitable for connection with any DALI network

DMX

STEVAL–ILL030V1
LED lighting control using DMX512 control based on STM32F102C6 and STCS1A

- Configuration of the board mode as transmitter, receiver or standalone
- Up to 512 receivers can be connected to the DMX host

PLC

STEVAL-IHP005V1
General purpose ST7540 power line modem module based on ST7540 PLM and STM32 microcontroller

- Simple API stack inside
- Easy point to point and point to multipoint communication

Communication in LED lighting: solutions (2/2)

RF Sub-GHz

STEVAL–IKR001V1, V2/V3/V4/V5
Sub-GHz transceiver development kit based on the SPIRIT1

- STM32L microcontroller based mother board
- Modulation schemes: 2-FSK, GFSK, MSK, GMSK, OOK and ASK
- Programmable through GUI

RF ZigBee

STM32W-RFCKIT
STM32W Low cost RF control kit

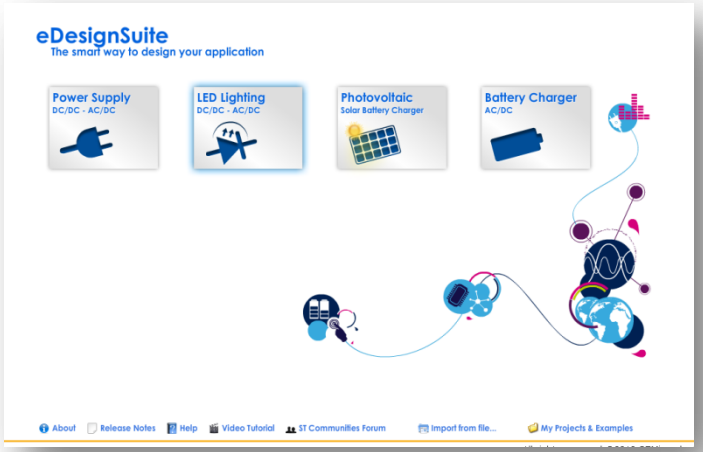
- The kit includes 1 remote board and 1 receiver board
- 802.15.4, ZigBee RF4CE, ZigBee, 6LoWPAN (contiki) wireless protocols

STEVAL-IDZ30*V1
Demonstration kit
for the SPZB32W1 series
of 802.15.4/ZigBee
radio communication modules

- Integrated RF module belonging to the SPZB32W1 series of IEEE 802.15.4 ZigBee® modules
- The kit contains a software library including utilities and application samples
- Hardware support for application development(temperature sensor, circuit for battery voltage, two configurable LEDs, two configurable push buttons)

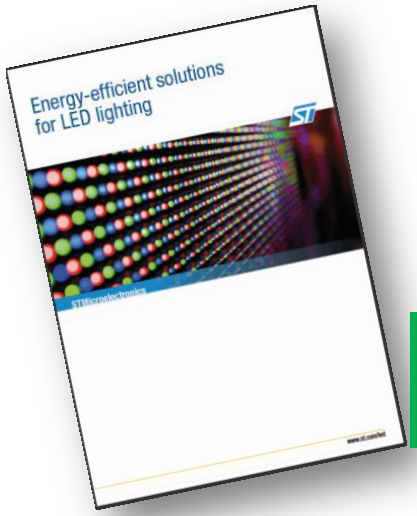
is used as a wildcard character for related part number,

LED lighting: tools



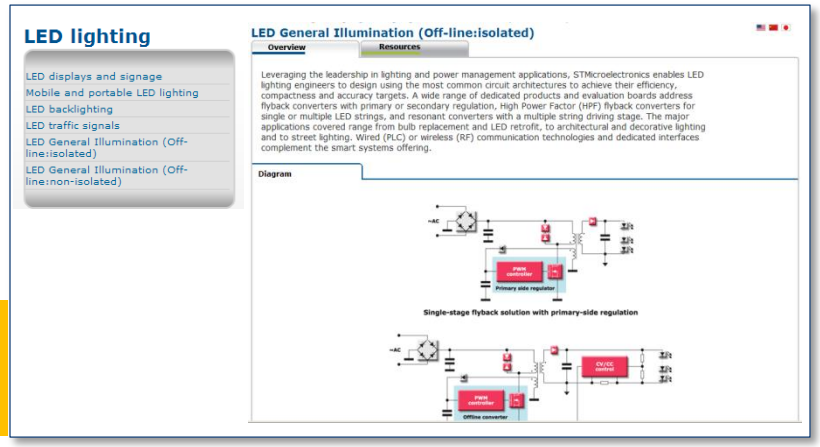
eDesignSuite
Smart simulator tool

www.st.com/edesignsuite



LED lighting brochure

www.st.com/ledlighting


LED lighting
LED displays and signage
Mobile and portable LED lighting
LED backlighting
LED traffic signals
LED General Illumination (Off-line:isolated)
LED General Illumination (Off-line:non-isolated)
LED General Illumination (Off-line:isolated)
Overview
Resources
Leveraging the leadership in lighting and power management applications, STMicroelectronics enables LED lighting engineers to design using the most common circuit architectures to achieve their efficiency, compactness and accuracy targets. A wide range of dedicated products and evaluation boards address flyback converters with primary or secondary regulation, High Power Factor (HPF) flyback converters for single or multiple LED strings, and resonant converters with a multiple string driving stage. The major applications covered range from bulb replacement and LED retrofit, to architectural and decorative lighting and to street lighting. Wired (PLC) or wireless (RF) communication technologies and dedicated interfaces complement the smart systems offering.
Diagram
Single-stage flyback solution with primary-side regulation

LED application web pages

www.st.com/ledlighting